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REDUCTION OF URBAN VULNERABILITY

Part V
of the
Report of

PROJECT EAST RIVER

July, 1952

Associated Universities, Inc.
New York, New York

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URBAN VULNERABILITY

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PROJECT EAST RIVER

July, 1952

Prepared under Signal Corps Contract No. DA-49-025-SC-96

Associated Universities, Inc.
New York, New York

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v. 5

July 31, 1952

The Honorable Millard Caldwell, Administrator,
Federal Civil Defense Administration

The Honorable Jack Gorrie, Chairman,
National Security Resources Board

The Honorable Robert A. Lovett, The Secretary of Defense

Dear Sirs:

The assignment of PROJECT EAST RIVER has included the evaluation and recommendation of "the optimum combination of non-military measures which will assist . . . The Federal Civil Defense Administration to discharge its responsibilities for preparing to minimize the effects of attack . . . on the population and industry of the United States and . . . The National Security Resources Board in discharging its responsibilities to advise the President concerning the strategic location of industries, services, government, and economic activities, the continuous operation of which is essential to the Nation's security . . . "

The threat of mass destruction by the weapons of the atomic era has been discussed in other parts of the PROJECT EAST RIVER report. The importance and the magnitude of the problem of protecting concentrations of population and industry have been recognized. Unfortunately, there are no comfortable, easy solutions. Standards are most difficult to set: the adequate tend to be unacceptable; the acceptable tend to be inadequate. Hence, there has been a natural tendency to delay in hope of finding palatable solutions and the tendency has also been to emphasize nondisruptive, nondisturbing, and hence ineffectual measures.

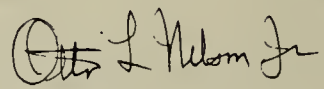
Part V of the PROJECT EAST RIVER report discusses the benefits that might be accomplished through improved construction standards and through a more effective use of space. The National Security Resources Board, in its efforts to communicate to others the urgency of the situation, has consistently pointed out to the people of the United States the serious vulnerability of our great metropolitan and industrial areas. Substantial increments of industry and population are still being added to prime target areas with almost complete disregard for spacing and other protective measures that represent necessary adjustments to a perilous atomic era. The seriousness of this situation demands, in our opinion, positive action. PROJECT EAST RIVER believes that it is illogical to expect industry to accept standards that the Federal Government ignores for that reason an interim report, Part II-B, "Federal Leadership to Reduce Urban Vulnerability," was

issued. The interim report contains the standards that were developed in this Part V of the Report. Thus, there is duplication between these parts of the report.

There are three appendices to Part V: Appendix V-A, "Selected Area Study," discusses the analysis of target vulnerability from the point of view of shelter requirements and potentialities and estimates of physical damage and number and types of casualties; Appendix V-B, "Minimum Density and Spacing Requirements for Metropolitan Dispersion", is a study of the economic limitations of dispersion; Appendix V-C, "Land-Use Policy and Standards of Urban Development in the USSR", discusses the trends in Russian city development for comparison with the situation in the United States.

It is believed that these first, admittedly imperfect steps recommended in this report could mark the beginning of a far-reaching program that, in addition to meeting requirements for national defense, has peacetime benefits in making this country a better place in which to live and work.

Sincerely yours,



Otto L. Nelson, Jr.

Director

PROJECT EAST RIVER

ACKNOWLEDGMENTS

The Panel is grateful to staff members of the National Security Resources Board, the Department of Defense, and the Federal Civil Defense Administration for their helpful cooperation in making available to the Project general information and data on current programs and planning. Acknowledgment is also made of helpful comments and constructive criticisms received from a number of leading architects, civil engineers, and city planners.

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FOREWORD

This Panel of PROJECT EAST RIVER was established to study measures for reducing the vulnerability to strategic attack of centers of population and industry in terms of defense by space and defense by structures. The problem is concerned primarily with less than 100 urban concentrations in which a major proportion of both the population and the industrial power of the United States is concentrated. The Panel concludes that it is possible, within a reasonable time, (1) to redevelop the older central cities at lower densities and to guide new metropolitan growth so as to reduce very significantly the effect of any one attack or series of attacks (defense by space), and (2) to build enough resistance into existing and new structures which must be exposed to the possible effects of modern weapons to prevent a very substantial percentage of possible casualties (defense by structures).

The recommendations of the Panel first take the form of a set of standards for future urban development, in terms both of decongestion and spacing and of resistance to fire and blast; steps are then recommended to guide public and private building in accordance with these standards; and finally, special programs are proposed for the planning of fire prevention, of shelter designation and construction, and of urban and metropolitan dispersion.

This report is not classified in the sense of military security. For this reason no specific reference is made to the possible effects of atomic weapons more powerful than those which have been publicly discussed. PROJECT EAST RIVER realizes that future weapons development may call for higher standards of structural protection and of spacing. Bearing in mind, however, the economic limits of dispersing urban concentrations and of building protection into old and new structures, the Panel is of the opinion that the recommendations in this report reflect a practicable set of standards which, if realized, would decrease the vulnerability of urban America by an important and measurable amount.

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I SCOPE OF THE PROBLEM

1. AN ELEMENT IN NATIONAL SECURITY

In any future war, the metropolitan areas of the industrialized nations will constitute primary targets for attack by modern weapons. Even though it may be economically and physically impossible to make these areas completely invulnerable to attack, a major objective in defense must be an increased chance for survival of people, industrial production, transportation, and urban services.

Reduction of urban vulnerability has become essential because this is a period in which atom bombs can be mass-produced by any great industrialized nation. The cost of a long-range bomber is now several times the cost of an A-bomb. When the great powers have stockpiled as many A-bombs as can effectively be used, relative target vulnerability will become a decisive factor in the outcome of war. In short, to keep pace with weapons development, it is essential to make urban targets less remunerative.

2. URBAN TARGET ATTRACTIVENESS

After a number of briefings on theories of United States vulnerability and target systems PROJECT EAST RIVER concluded that on whatever theory one proceeds the metropolitan areas of the Nation contain the greatest concentration of prime targets. Population and industry are so closely associated in most instances that A-bombing of areas of population concentration will yield high returns in damage to production facilities and vice versa.

For purposes of civil defense, therefore, it is not necessary to choose between the worker, the productive facilities he uses, and the community in which he lives. To be effective against modern weapons, protection must be conceived on a scale which covers entire concentrations of population and industry.

Targets for enemy attacks are found principally in the standard metropolitan areas of the United States where 60 per cent of the population live, where approximately two-thirds of all factory and wage earners are located, and where skilled labor, technicians, scientists, management personnel and other key men are heavily concentrated. (See figure 1.)

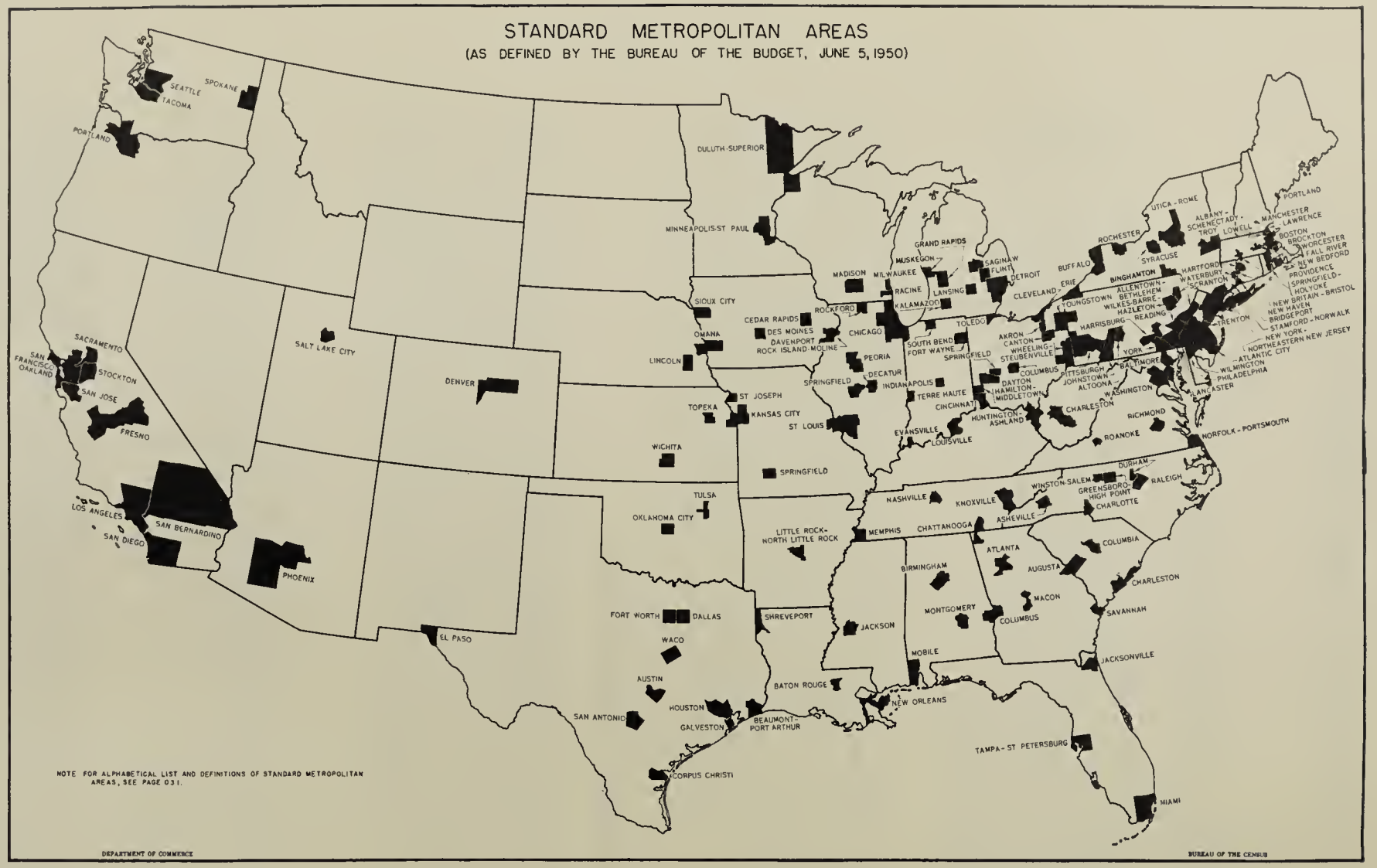


FIGURE 1

STANDARD METROPOLITAN AREAS

Sixty per cent of the population of the United States and approximately two-thirds of all factory and wage earners are located in these metropolitan areas.

These facts are not cited to minimize the importance of the Nation's rural people or the products they produce. Present urban areas, however, must be recognized as being so greatly concentrated in space that they create a type of target attractiveness which rural areas do not present.

Thirty-three million people live in the central cities of the 32 largest metropolitan areas, the total areas of which are equivalent to a 55-mile square. (See figure 2.)

In THE EFFECTS OF ATOMIC WEAPONS[1], it is indicated that the area of complete destruction and severe damage from a Hiroshima type or nominal A-bomb extends about a mile from ground zero, or, in other words, covers an area of about 3.1 square miles.

The ground area of these central cities, then, is the equivalent of the area of total and heavy damage to structures of only 1,000 nominal A-bombs. The magnitude of the threat by even nominal A-bombs must be visualized in terms of millions of homeless families and the estimate that there are insufficient medical resources in any city of the United States to take care of the casualties.

Forty-five per cent of the Nation's industrial workers and population are within range of missiles which today can be successfully launched from submarines. (See figure 3.) Over half of the Nation's foreign and coastwise commerce is carried on in six ports, all of which are highly vulnerable to the effects of atomic bombing either by air or water burst. Over one-quarter of this commerce is concentrated in the port of New York.

In general, these same concentrations create a vulnerability to the effects of chemical and biological warfare.

3. ELEMENTS OF URBAN VULNERABILITY

a. Density of Population

At or near ground zero, in the area of almost complete destruction, the chances of survival are very small, and any greater or smaller density of population within the area of complete destruction would in no way change the chances of survival for the individuals in the area. At the other extreme, individuals situated ten miles from ground zero have excellent chances of survival. An increase (or decrease) of the density of population in the fringe areas would have little effect on survival.

[1] Atomic Energy Commission, THE EFFECTS OF ATOMIC WEAPONS, U. S. Government Printing Office, 1950, Figure 12.4a, p. 368.

FIGURE 2
POPULATION CONCENTRATION

In 1950 thirty-three million people lived in the central cities of the 32 largest metropolitan areas, the total areas of which are equivalent only to a 55 mile square, illustrated above.

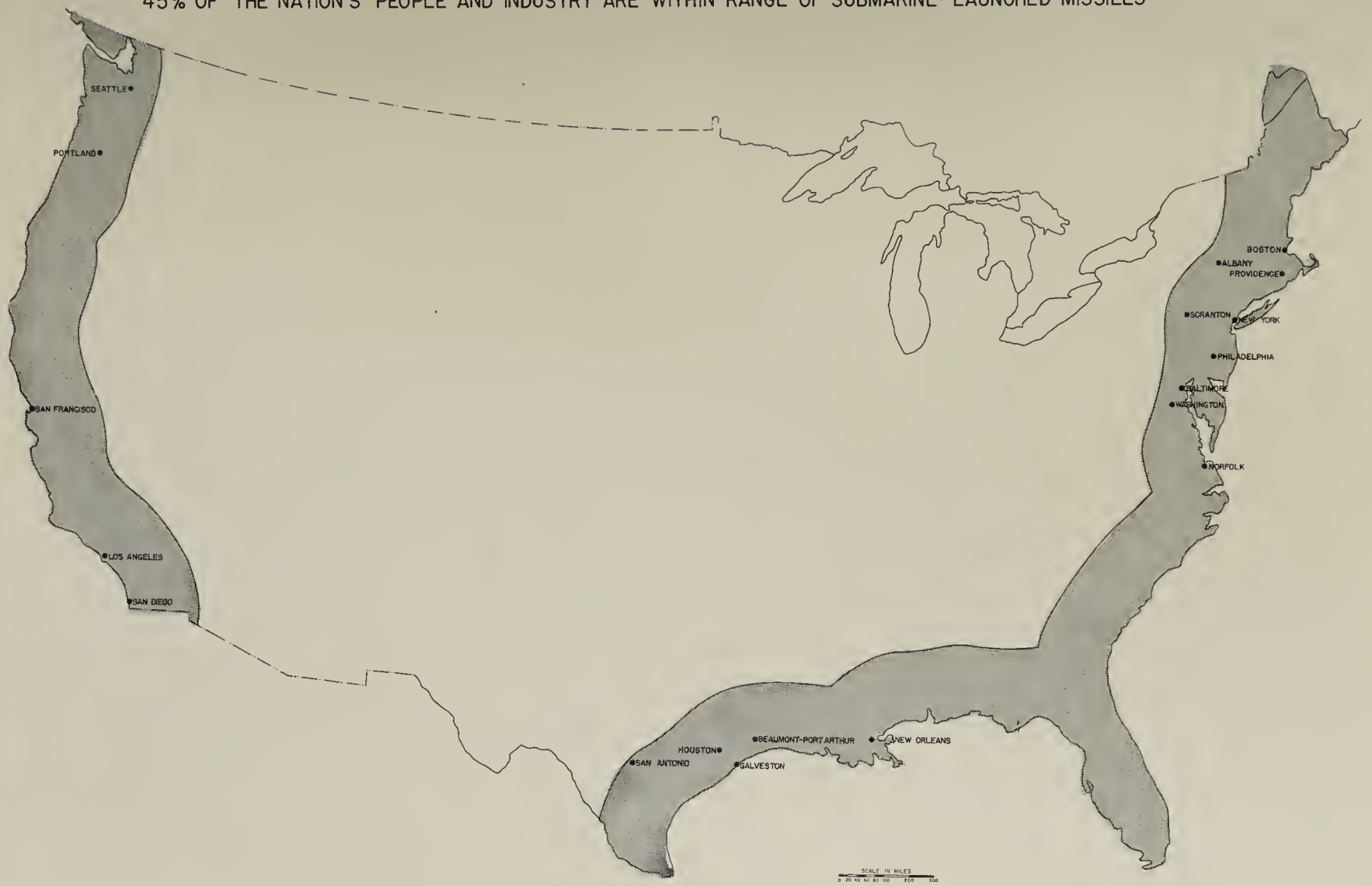


FIGURE 3

COASTAL CONCENTRATIONS

Fourty-five per cent of the nation's industrial workers and population are within range of missiles which today can be successfully launched from submarines, as illustrated by the shaded area above.

In the intermediate areas of heavy to medium damage, bomb effects are very sensitive to distance from ground zero, falling off at an exponential rate with increasing distance. The effects follow the cube-root scaling law for atomic explosions of different magnitudes. As a consequence, any measures to modify the population density by moving individuals in the intermediate areas will greatly increase the individual chances for survival. It follows, therefore, that in the intermediate areas, spacing (or decreasing the density of population) increases the chances of survival at a geometric (or greater) rate.

These remarks are only applicable to the survival chances of those individuals in the intermediate areas as determined by the actual bomb drop. It is recognized that the situation described is oversimplified in that the effects of other important factors such as height of bomb burst and meteorological conditions have been neglected.

If a target area is considered which is very large compared to the area of bomb damage, the number of casualties will vary directly as the density of population. It is obvious, for example, that if the spacing were doubled, thereby decreasing the density by a factor of four, the number of casualties would be reduced by a factor of four even for the area of complete destruction. The chances of survival for the individuals in the area of complete destruction remain very poor, regardless of the decreases in population density. Additional information on the destructive effects of atomic weapons is presented in PROJECT EAST RIVER REPORT Part III, The Destructive Threat of Atomic Weapons.

b. Strength and Design of Structures

Modern buildings of steel or reinforced concrete skeleton are substantially more resistant to the effects of atomic attack than buildings in which the roof and floor structures are carried on masonry walls that may collapse under blast. More resistant still are buildings in which the skeleton is designed to stand substantial lateral movement as well as the normal forces; this is typical of earthquake design. Unfortunately, although resistant structures of this type may be very little more expensive and may offer many other advantages in addition to blast resistance, a substantial number of wall-bearing buildings are still being built in central-city areas, and even the substantial buildings rarely take advantage of the major benefits to be gained by minor and inexpensive changes in structural design.

c. Fire Resistance

Perhaps the greatest danger associated with the congested centers of cities in the United States is fire, because this danger is always present. It stems partly from the character of the buildings, many of which

are combustible types. Partly it is the result of permitting in central areas such critical fire risks as wood and fuel storage yards without adequate measures to avoid fire or to make it possible to isolate and fight it. Most of all, however, the fire danger comes from the combustible contents of the buildings. Despite the advances made under building and fire codes, housekeeping and fire prevention measures typical of the normal city in this country leave much to be desired. In some of the most congested urban areas, where roofs of combustible structures represent more than 20 per cent of the entire area of a square mile or more, there is the added risk of the simultaneous initiation of many small fires which will combine to form the dreaded fire storm.[2] (See figure 4.) Once a fire storm is under way, everything in the area will be burned out, regardless of how well constructed individual buildings may be. All those who remain in shelters in the fire storm area will be killed. At the present time, not only is there no serious attempt to solve this problem, but substantial new buildings are being erected in the midst of these areas of critical danger.[3]

4. INCREASING URBAN VULNERABILITY

a. Urban Population Movements

Regional shifts from one part of the Nation to another are relatively minor although there is a discernible trend from east to west and south. The West Coast had approximately 3 per cent of the Nation's people and manufacturing 50 years ago. Today this percentage has changed from 3 per cent to 9 per cent, a dramatic shift in terms of the West Coast itself, but only a 6 per cent change in 50 years for the Nation as a whole. More important than California's gains or New England's losses in recent years is the fact that the industrial heartland of the Nation (Massachusetts to Illinois) has maintained itself for the last 50 years as the home of approximately 45 per cent of the Nation's population and 60 per cent of the production workers. (See figure 5.)

Historically, wars have always added industry to central cities in the United States. For example, while one effect of World War II plant location was to spread industry to the south and west, its more important net effect was to intensify and fill in the existing central-city pattern. Between 1939 and 1947 in the 53 census-standard industrial metropolitan areas one and one-half million workers were gained in the central cities as compared to 900,000 gained in their environs.

[2] Bond, Horatio (ed). FIRE AND THE AIR WAR. BOSTON: National Fire Protection Association, 1948.

[3] For current Soviet policy with regard to building densities, see Appendix V-C, LAND USE POLICY AND STANDARDS OF URBAN DEVELOPMENT IN THE USSR.

FOUR STAGES OF SAN FRANCISCO CONFLAGRATION

APRIL 18-20, 1906

ONE AREA OF SIMULTANEOUS BURNING — HAMBURG

JULY 28, 1943

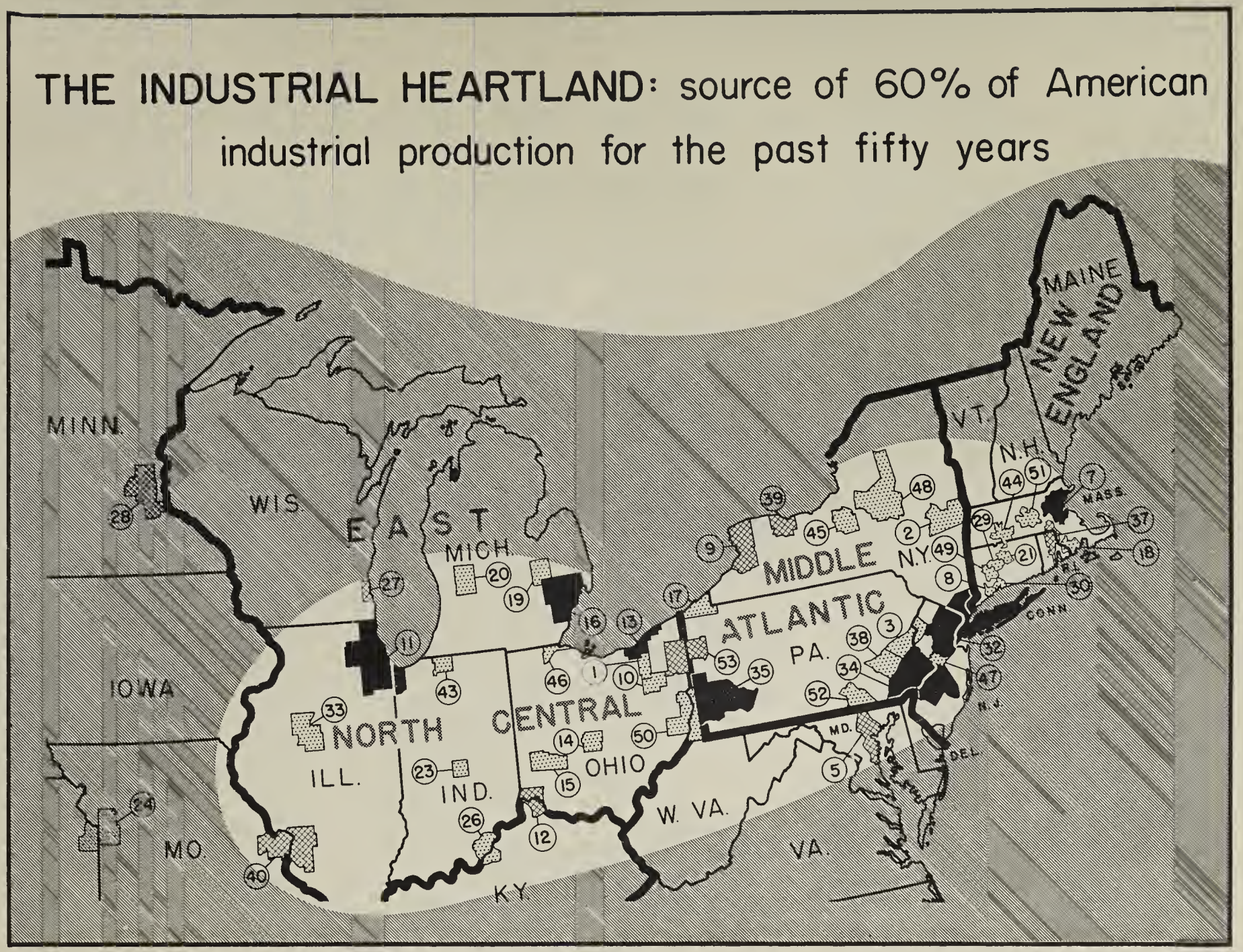
AREAS ON FIRE AT ONE TIME IN SOLID BLACK
BURNED-OVER AREAS IN LIGHT SHADING

ONE SQUARE MILE

FIGURE 4

CONFLAGRATION VERSUS FIRE STORM

The San Francisco conflagration of 1906, the largest which ever occured in the United States, compared with the great wartime fire in Hamburg which was marked by a fire storm. The conflagration burned in stages over a period of three days. The burning in the Hamburg fire took place practically simultaneously, the buildings in the area shown burning until they were consumed. The areas shown as unburned in Hamburg within the black area were open spaces.


THE INDUSTRIAL HEARTLAND: source of 60% of American industrial production for the past fifty years
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WIS.
EAST
MICH.
IOWA
NORTH
CENTRAL
ILL.
IND.
OHIO
MO.
KY.
W. VA.
VA.
MIDDLE
ATLANTIC
N.Y.
PA.
MD.
DEL.
N.J.
CONN.
R.I.
MASS.
VT.
N.H.
MAINE
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FIGURE 5

Another important trend is growth within the rapidly expanding metropolitan areas which has gone to either suburban or satellite areas. In contrast to the increased numbers of people working in the centers, resident population increased more rapidly in the metropolitan environs: 9,000,000 as compared with 6,000,000 in central cities over the last decade. (See figure 6.) The rate of growth in suburban areas was 35 per cent as compared with 14 per cent for central cities.

From the point of view of civil defense, however, the most important movement of population has been the continuous trend from nonmetropolitan to metropolitan areas. The 1950 census showed a metropolitan area population gain of 22 per cent, three and one-half times the growth of nonmetropolitan areas during the preceding decade. In fact, since the first census of 1790 the Nation has gained steadily in urban concentrations.

b. Increasing Urban Concentration

The relative attractiveness of central cities as targets is still increasing despite metropolitan expansion. Suburban areas with a wider spacing of people and industry are growing rapidly—yet the equivalent of 37 cities the size of Flint, Michigan was packed into the old central cities during the last census decade.

During the 18 months prior to December 31, 1951, of a total of 246 industrial plants locating in metropolitan areas with a central city having 100,000 or more population, 105 plants were reported as being built in the central cities as compared with 141 in the suburbs. The construction awards for the 105 plants represent an estimated construction cost of $492 ,000,000 as compared with $1,162,000,000 invested in the suburbs. [4]

These contract awards represent only a small part of the investment in urban expansion; they include only the cost of the factory building and not that of the machinery. They do not include warehouses or office buildings, most of which are located in the central cities.

Most important, however, from the standpoint of urban vulnerability, is that during this 18-month period, of every $10 invested in large new plants in metropolitan areas $3 was spent in central-city areas.

Of a total of 2,399 new plants built in the New York Metropolitan Area between 1946 and 1951, 593 were built within New York

[4] Engineering News-Record, March 27, 1952, p. 24.

FIGURE 6

EXPANDING METROPOLITAN AREAS

The rate of population growth of suburban areas in the decade 1940-1950 was more than twice the rate of growth of central cities.

City;[5] 934, or more than one-third, were built within 10 miles of southern Manhattan. (See table I.) A better measure of how these new plants have increased the vulnerability of the New York Metropolitan Area can be gained from the fact that half of their dollar value is concentrated within 10 miles of Newark's industrial center. (See figure 7.)

TABLE I

GEOGRAPHICAL DISTRIBUTION OF PLANTS BUILT 1946—1950 IN THE NEW YORK—NORTHEASTERN NEW JERSEY METROPOLITAN AREA

Distance from Southern Manhattan	Number of Plants	Per Cent of Total
0-10 miles (includes Newark, Jersey City)	934	38.9
0-15 miles	1431	59.6
0-20 miles	1849	77.1
Total new plants built in entire metropolitan area	2399	

No comparable information is available concerning the location and amount of commercial and office buildings. Downtown department stores have increased their number of suburban branches and the main stores, traditionally located in central cities, have not expanded. However, surveys indicate that the central business districts are maintaining, if not strengthening, their hold on volume of office space. It is reported that in the period between the end of World War II and the start of the Korean conflict—roughly five years—some 30 million square feet of rentable office space was put on the market, an increase over these years of 13 per cent.

The apparent trend towards increased office building in central cities is confirmed by a report recently published by the Real Estate Board of New York, Inc. In Manhattan, almost 6 million square feet of new competitive (rentable) and noncompetitive office space has been built since 1947. Two million additional square feet approved for construction by the National Production Authority are either now under construction or expected to be constructed in 1953. This represents an increase of over 10 per cent of Manhattan's office space since 1947. Through boom, depression, war, and post-war periods from 1925 to date, Manhattan has had an average annual increase of over 1 million square feet of competitive office space. Other cities with important new post-war office construction include Pittsburgh, Chicago, Boston, Washington, D. C., Houston, Portland (Oregon), and Seattle.

[5] New Industrial Location in the New York Metropolitan Region, 1946 through 1950, Bulletin No. 80, Regional Plan Association, Inc., New York, 1952.

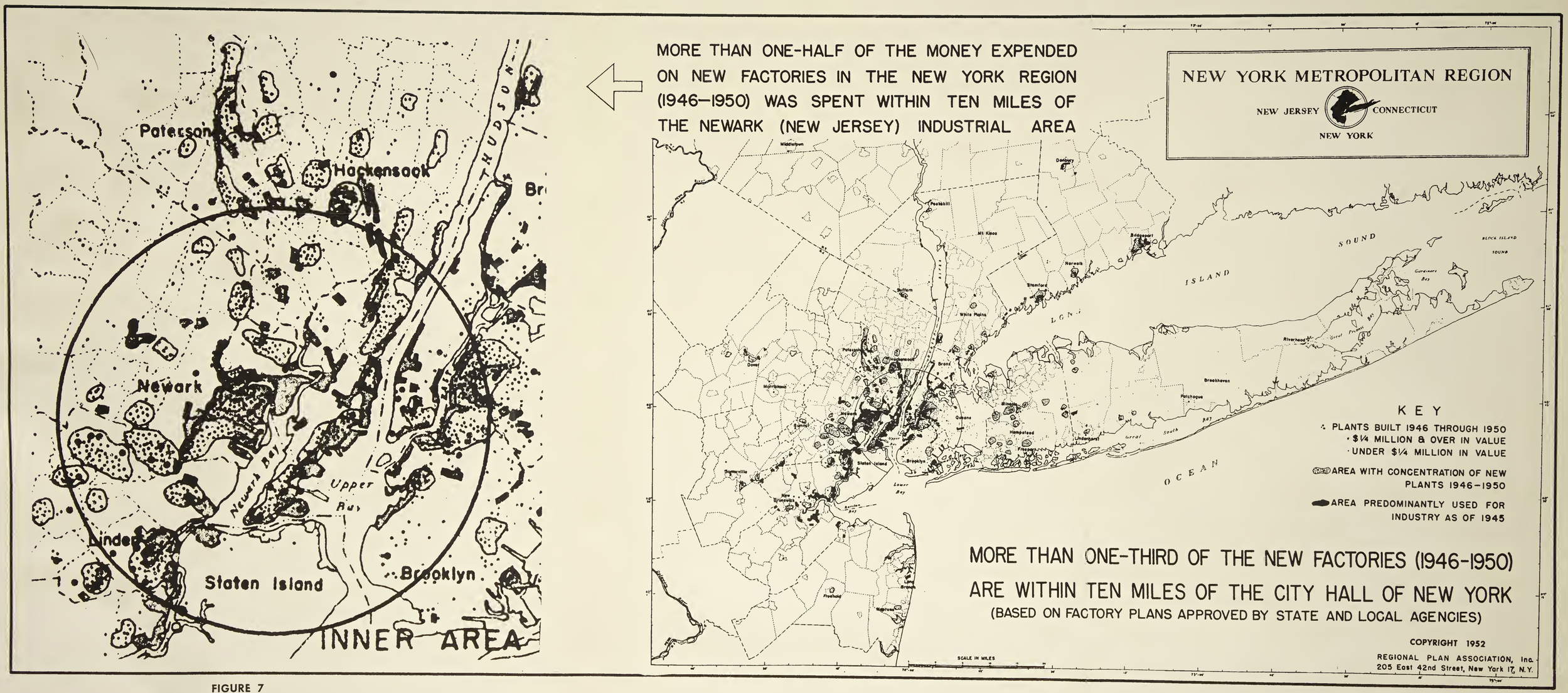

Paterson
Hackensack
Newark
Newark Bay
Upper Bay
Linden
Staten Island
Brooklyn
INNER AREA
MORE THAN ONE-HALF OF THE MONEY EXPENDED ON NEW FACTORIES IN THE NEW YORK REGION (1946–1950) WAS SPENT WITHIN TEN MILES OF THE NEWARK (NEW JERSEY) INDUSTRIAL AREA
NEW YORK METROPOLITAN REGION
NEW JERSEY
CONNECTICUT
NEW YORK
KEY
PLANTS BUILT 1946 THROUGH 1950
$1/4 MILLION & OVER IN VALUE
UNDER $1/4 MILLION IN VALUE
AREA WITH CONCENTRATION OF NEW PLANTS 1946–1950
AREA PREDOMINANTLY USED FOR INDUSTRY AS OF 1945
MORE THAN ONE-THIRD OF THE NEW FACTORIES (1946-1950) ARE WITHIN TEN MILES OF THE CITY HALL OF NEW YORK
(BASED ON FACTORY PLANS APPROVED BY STATE AND LOCAL AGENCIES)
COPYRIGHT 1952
REGIONAL PLAN ASSOCIATION, Inc.
205 East 42nd Street, New York 17, N.Y.
SCALE IN MILES

FIGURE 7

Daytime concentrations of people contribute to the problem of urban vulnerability. The flow of workers and shoppers to downtown areas adds over 10 million persons to the prime target areas in 57 cities.[6] This represents a daytime population gain of 75 per cent for these areas. The daytime gain for the central cities, as a whole, is 20 per cent. In the southern part of New York's Manhattan Island, to cite the Nation's most dramatic situation, three and three-quarter million persons enter each working day and leave each evening.

The Federal Government adds its share to daytime downtown concentrations of workers. Twenty-five per cent of all civilian employees of the executive branch of the Federal Government work in four metropolitan areas; the majority of these employees work in the central cities. Over 200,000 civilian employees of the executive branch of the Government alone are concentrated within two miles of the White House in Washington, D. C. A similar number are concentrated in the New York—Northeastern New Jersey area and the San Francisco—Oakland area together. Although no figures are available for the numbers of military personnel or personnel of the Government's legislative and judical branches, their numbers add further to the concentrations.

In general, while there is a marked trend of new residential and related retail development in suburban areas, industrial and commercial expansion is continuing in central areas. Although some industrial and commercial activities have been moving out of central areas at a slow rate during the past 50 years, a trend interrupted by World Wars I and II but now resumed, the rate of movement is low, affording no promise that dispersion will occur automatically on any large scale. The trends indicate, however, that dispersion of many industries and other job-producing activities from central to peripheral locations in metropolitan areas could be accomplished without major diseconomies.[7] In relation to urban vulnerability, it is essential that these trends of dispersion be accelerated and guided on a metropolitan basis so as not to produce new or expanded target areas.

c. Structural Standards

Considerable progress has been made in recent years towards increasing the strength and fire resistance of buildings, but current building standards are inadequate in meeting the threat of atomic attack. At little or no additional cost, new buildings can be designed to provide adequate protection for their occupants, and the structural members can be designed

[6] Preliminary estimate made by Project East River and the Bureau of the Census.

[7] See Appendix V-B, Minimum Density and Spacing Requirements for Metropolitan Dispersion.

to resist the unusual forces created by an atomic blast. Combustible components can be sharply reduced, and the combustible contents of buildings can be separated by compartmentation into units of manageable proportions and protected where necessary by sprinkler systems supported by a self-contained water supply. Most important of all, particularly with reference to fire storms, are measures to reduce urban congestion itself.

The trends in structural standards are in this direction at the present time. On the other hand, the atomic bomb greatly increases the hazards with which building and fire engineers have been accustomed to dealing, and it will not be sufficient for people to sit back and wait until existing trends have carried protective measures to the level which is needed. The task is to accelerate the public demand for fire-resistant construction and low-density development and to secure substantial added protection against blast effects at little or no addition in cost.

5. POSSIBILITY OF REDUCTION OF URBAN VULNERABILITY

The task of building relative protection into existing urban development and current additions to it is not an impossible one.

As to existing urban areas, it is estimated that casualties in the event of an attack could be reduced by as much as 75 per cent[8] if a warning time of one hour and adequate shelters were available. The cost of an effective shelter program does not appear prohibitive.

American cities are growing and changing so rapidly that reasonable controls over new development could effect a large reduction in over-all vulnerability in a few years. It has been estimated that the total physical structure of the Nation's major cities—the houses, streets, stores, schools, factories, water systems and other facilities that provide the physical basis for city living—increased about 25 per cent in size during the past decade, a net addition to the urban structure of 2.5 per cent a year. "Close to one million urban dwellings are being built in this country annually together with a corresponding amount of the other elements of urban growth such as schools, churches, business and industrial buildings, streets, and utilities. In short, urban structure equivalent to that of a city of three and a half million people is being built in the United States each year. Capital investments running into billions of dollars are represented in this annual

[8] Lehigh University Institute of Research, in estimates prepared for Federal Civil Defense Administration, 1951, set the casualties avoided by its suggested shelter program at 77%, lives saved at 71%. For discussion of Lehigh Report see page 95.

'plant' expansion and development."[9] To illustrate these figures it may be pointed out that a city of three and a half million is the equivalent of a Chicago, or a Los Angeles plus a Detroit, or four Bostons. Every three years an urban area almost equivalent to the New York—New Jersey metropolitan area is built in the United States.

[9] Statement of Policy on Urban Development and Expansion, American Institute of Planners, 1950.

II REDUCTION OF URBAN VULNERABILITY BY SPACE

The preceding section has outlined the nature and scope of the vulnerability of centers of population and industry in the United States to attack by atomic and other weapons. The discussion has indicated that reduction of urban vulnerability can be achieved by two nonmilitary measures: (1) *spacing* (decongestion of existing cities and better standards of spacing of new urban developments) to reduce target attractiveness and (2) *structural protection* (providing shelter in existing structures, developing fire-prevention standards, and building new structures to bomb-resistant standards) to make urban areas more able to withstand attack. This section presents an approach to the urban vulnerability problem in terms of defense by space.

1. NEEDED: FEDERAL LEADERSHIP[10]

While the Federal Government has long been directly involved in the development of long-range programs of soil conservation, irrigation, and agricultural improvement in rural areas, there has been no major need prior to the advent of the atomic bomb for the Federal Government to be concerned with problems of congestion of industry and people in urban areas. It has therefore been difficult for the Government to determine how it should proceed now that centers of population and industry have become the most lucrative targets for new weapons. As the authority on defense matters, the Government is expected to provide leadership in this field. The program, however, should not substitute, under the guise of national defense, centralized Federal control for traditional independence in local affairs.

The reluctance of the Federal Government to become involved in local problems of plant location and congestion of industry and population has been a major determinant in everything that has been attempted thus far. It was a useful first step for the National Security Resources Board to inform the entire country about the problem and to suggest that intelligent self-interest would be sufficient motivation to produce the desired program.

[10] See Federal Leadership To Reduce Urban Vulnerability, Project East River Part II-B, June 1952.

In promulgating the National Industrial Dispersion Policy in August 1951, the President directed that applications for aid for industrial expansion of defense plants, as well as allocation of critical materials for construction purposes, be reviewed so that new essential defense industry will be dispersed within a given market area. This policy did not aim to reduce the over-all vulnerability of urban areas, but it did represent a first step which could be easily and rapidly implemented with proper Federal administration and coordination with local groups.

It must be recognized that the problem of reducing urban vulnerability is one which involves other factors in addition to the dispersion of new defense industry. These factors include:

(1) Guidance in the location of the great bulk of job producing activities in nondefense industry and commerce which are the economic base of growing centers of population, as well as in those new defense industries which do not now fall within the dispersion policy as administered by the Defense Production Administration. In this latter case, it has been noted that the Defense Production Administration's administration of the dispersion policy affects only new defense plants costing $1,000,000 or more or containing 15 per cent of national production capacity in any one line.
(2) Guidance of residential growth which accounts for 60 per cent of expenditures for urban expansion as compared with less than 3 per cent for industry.
(3) Application of construction standards to make new or existing structures in target areas better able to withstand attack.
(4) Consideration of the effect of dispersion on community services and facilities required in outlying areas.
(5) Consideration of official comprehensive metropolitan planning which is required to obtain the optimum dispersal program for any given metropolitan area.
(6) Consideration of the need for regional location or relocation of any category of industry.

In short, the National Industrial Dispersion Policy was simply intended to achieve a measure of protection through spacing of large new defense plants 10 to 20 miles from existing target areas. Within the limits of this intention, the policy was well conceived, and the techniques for its application were well worked out by the National Security Resources Board.

The National Industrial Dispersion Policy has, however, produced inadequate results, even in new defense plant location, since its inauguration in August 1951. In part, this has been the result of the apparent

inability or unwillingness of the Defense Production Administration (which issues certificates of necessity and allocates critical materials), the Reconstruction Finance Corporation (which grants loans based on certificates of essentiality), and the Department of Defense (which awards contracts for defense production) to subordinate urgent production requirements. The necessity to step up defense production was considered, perhaps rightly, so urgent as to condone the flaunting of minimum prudent measures to reduce the vulnerability of centers of industry and population. A very substantial amount of defense plant construction in target areas was undertaken on the basis of tax amortization certificates and other Federal aids. The administration of dispersion procedures by the Defense Production Administration did not begin until June 1952, 10 months after the policy was announced.

The major defect in present policies seems to have been undue reliance on local volunteer committees in each metropolitan area to furnish the initiative for defense plant dispersion that can come only from the Federal Government. The slogan has been "Community responsibility —Federal guidance." It would, of course, be highly desirable for dispersal to come as a "grass roots" movement. However, no community or local committee can carry out what is essentially a major responsibility of the Federal Government. Until the Federal Government precisely defines the standards and the program to be undertaken, local action can not be effective. PROJECT EAST RIVER approves the industrial dispersion policy as far as it goes, and believes it was a necessary and appropriate beginning, but it urges a broadening of the policy to cover a greater range of the problem.

National defense is a Federal responsibility. If reduction of the Nation's urban vulnerability is esential to national defense (as PROJECT EAST RIVER believes that it is), then the Federal Government must meet its leadership obligations in this field. No one community, no single state is in a position to adopt and enforce urban defense standards until other cities and states are subject to the same standards. Local communities and even states do not possess the facts on which to develop such standards. The outstanding authorities in the science of atomic warfare are associated with the Federal Government, and the security aspects of their work prevent the release of information upon which defense standards need to be based. The ability to assembly these facts and the duty of interpreting them clearly lie in the province of the Federal Government. Private business and local and state governments will implement their programs when the Federal Government demonstrates its leadership and establishes standards to govern its own activities in centers of population and industry. Until this is accomplished, the states, municipalities, and private investors

will assume that, insofar as national defense is concerned, "building-as-usual" is the order of the day.

2. DEVELOPING STANDARDS FOR DECONGESTION AND SPACING

PROJECT EAST RIVER believes that a set of standards for the decongestion of existing urban target areas (for example, the largest central cities) and the spacing of new urban development (for example, new suburban areas) should be established without further delay. While these standards will of necessity be oversimplified and crude at first, the direction of the program must be set immediately in order that progress may be made in developing and applying more refined standards, as well as to check the present dangerous trends toward increasing vulnerability.

In the discussion which follows, a set of standards are developed which PROJECT EAST RIVER considers to be a good approximation of the necessary starting points and final goals in defense by space, subject to refinements through research and metropolitan land-use plans.

a. Urban Densities

If civil defense were the only consideration, the greatest security could be achieved by the widest possible spacing of homes, factories, and commercial establishments so as to eliminate target areas entirely. A modern industrialized society, however, requires urban concentrations. The problem, therefore, is one of achieving the best balance of dispersion or spacing within the practical limits of a properly functioning urban economy. In terms of population density, minimum limits appear to be between 2,000 and 8,000 persons per gross square mile with 5,000 to 6,000 persons per square mile as a theoretical optimum based on factors of labor supply, transportation, public services, balance of economic activity, provision of cultural functions, housing preference, housing economy, and amenity.[11]

Areas containing 2,000 persons (approximately 500 dwelling units) per square mile fall into the United States Census definition of "urban fringe" development or minimum development "normally found associated with a closely spaced street pattern." These areas would be typified by single-family houses on half-acre lots.

Areas containing 6,000 persons per square mile correspond approximately with single-family residential developments with six or seven families per net residential acre. Levittown, Pennsylvania, where houses are built on 70 foot lots, is an example of this type of development.

[11] See Appendix V-B, MINIMUM DENSITY AND SPACING STANDARDS FOR METROPOLITAN DISPERSION.

Areas containing 8,000 to 16,000 persons per square mile (considerably above the minimum limits of urban population density) include sections lying between low-density suburban areas and areas which have some central-city characteristics. The average density in these areas is from 8 to 10 families per net residential acre living in single-family homes and garden apartments. Such areas, if sufficiently extensive, are classified in this report as Class II Vulnerable Urban Districts. (See figure 8.)

Central-city areas with 16,000 persons and more per square mile have at least 18 to 20 families per net residential acre who live in row housing (attached houses usually 20 feet wide), garden apartments, and, in the more densely populated central areas of larger cities, wall-bearing tenements, multistory apartment houses, and multifamily wooden houses. Such areas, if sufficiently extensive, are classified in this report as Class I Vulnerable Urban Districts. (See figures 9, 10, and 11.)

b. Vulnerable Urban Districts

PROJECT EAST RIVER agrees with the National Security Resources Board that urban areas containing 200,000 or more persons per four-mile-diameter circle (concentrations of population of 16,000 or more persons per square mile) are attractive targets for atomic attack.[12]

For this reason PROJECT EAST RIVER has recommended[13] that the National Security Resources Board map and designate as Class I Vulnerable Urban Districts those highly industrialized and densely populated sections of urban areas that are enclosed by a line drawn through the centers of contiguous four-mile-diameter circles in each of which one or more of the following conditions apply: (1) defense-supporting plants each of which has 100 or more employees and which together have a combined employment of 16,000 workers; (2) residential population of 200,000 persons; (3) daytime population of 200,000 persons; (4) major military installations or other installations of strategic importance.

It may be noted that this definition of Class I Vulnerable Urban Districts includes areas defined[14] as "attractive atom-bomb targets" for purposes of the National Industrial Dispersion Program and adds there-

[12] A Question and Answer Guide on The National Industrial Dispersion Program, National Security Resources Board, February 1952.

[13] Federal Leadership to Reduce Urban Vulnerability, PROJECT EAST RIVER, Part II-B, June 1952.

[14] Industrial Dispersion Guidebook for Communities, U.S. Department of Commerce, Domestic Commerce Series No. 31, 1952.

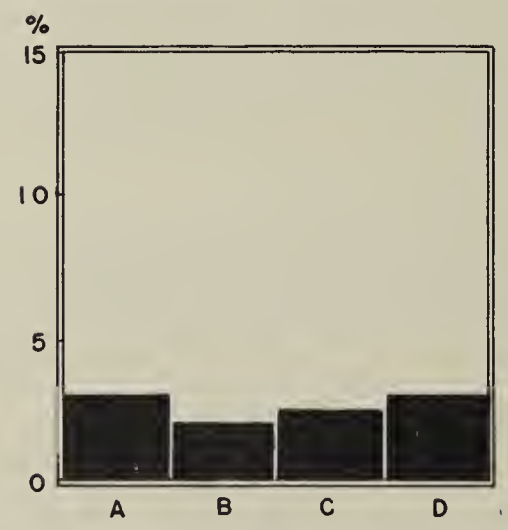
POPULATION DENSITY BY STRUCTURE TYPES

12,000

PERSONS PER SQ. MILE
OF DEVELOPED RES. LAND

SINGLE - FAMILY
DWELLINGS

MAJOR NON-RESIDENTIAL USES



ONE SQUARE MILE

% OF AREA		
3%	A	MAJOR STREETS, HIGHWAYS AND THOROUGHFARES
2%	B	SEMI-PUBLIC LAND
2.5%	C	COMMERCIAL LAND
3%	D	LARGE PARKS, ETC.
90%		DEVELOPED RESIDENTIAL LAND

Chicago City Plan Commission

FIGURE 8

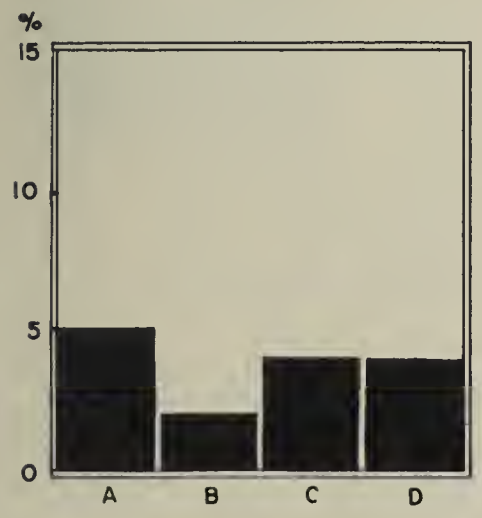
POPULATION DENSITY BY STRUCTURE TYPES

21,000

PERSONS PER SQ. MILE
OF DEVELOPED RES. LAND

GROUP HOUSES

MAJOR NON-RESIDENTIAL USES



ONE SQUARE MILE

% OF AREA		
5%	A	MAJOR STREETS, HIGHWAYS AND THOROUGHFARES
2%	B	SEMI-PUBLIC LAND
4%	C	COMMERCIAL LAND
4%	D	LARGE PARKS, ETC.
85%		DEVELOPED RESIDENTIAL LAND

Chicago City Plan Commission

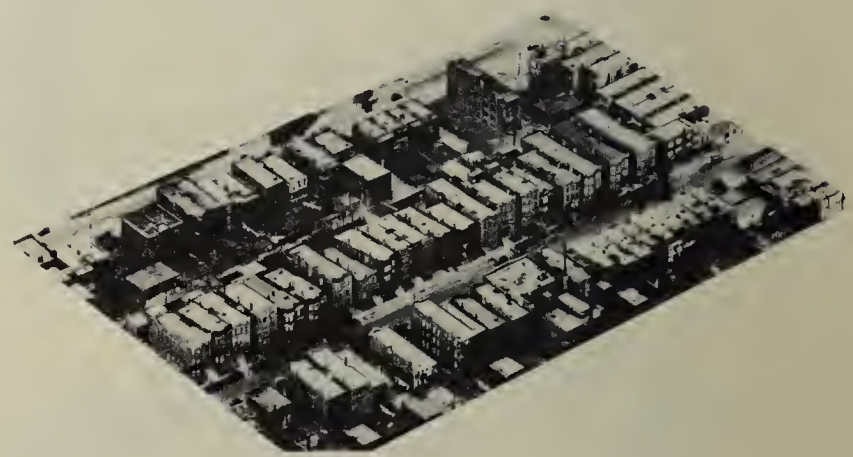
FIGURE 9

POPULATION DENSITY BY STRUCTURE TYPES

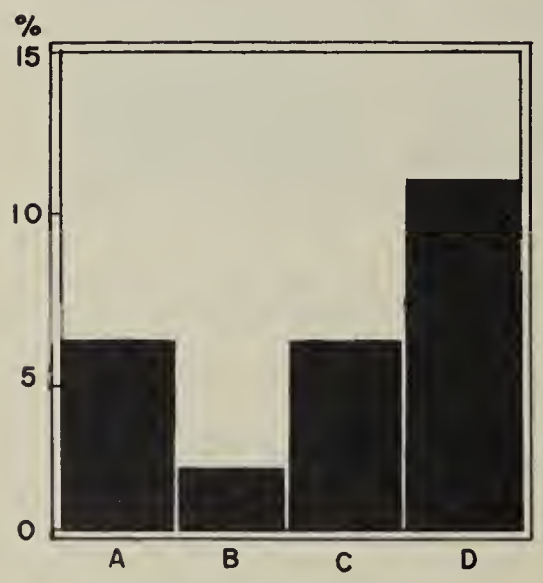
50,000

PERSONS PER SQ. MILE
OF DEVELOPED RES. LAND

APARTMENTS



MAJOR NON-RESIDENTIAL USES



ONE SQUARE MILE

% OF AREA		
6%	A	MAJOR STREETS, HIGHWAYS AND THOROUGHFARES
2%	B	SEMI - PUBLIC LAND
6%	C	COMMERCIAL LAND
11%	D	LARGE PARKS, ETC.
75%		DEVELOPED RESIDENTIAL LAND

Chicago City Plan Commission

FIGURE 10

to daytime population and major military installations or other installations of strategic importance.

PROJECT EAST RIVER has also recommended that the National Security Resources Board map and designate as Class II Vulnerable Urban Districts sections of urban areas that are enclosed by a line drawn through the centers of contiguous four-mile-diameter circles in each of which there is daytime or nighttime population of 100,000 persons.

Class II Vulnerable Urban Districts are less intensively developed than Class I Vulnerable Urban Districts. While the Class II Districts are not such prime target areas as Class I Districts, they nevertheless represent concentrations of population which are sufficient to make them attractive to attack. If permitted to grow in the fashion in which such areas usually develop, Class II Districts will either become prime targets or will add to attractive targets for atomic attack. (See figure 12.)

POPULATION DENSITY BY STRUCTURE TYPES

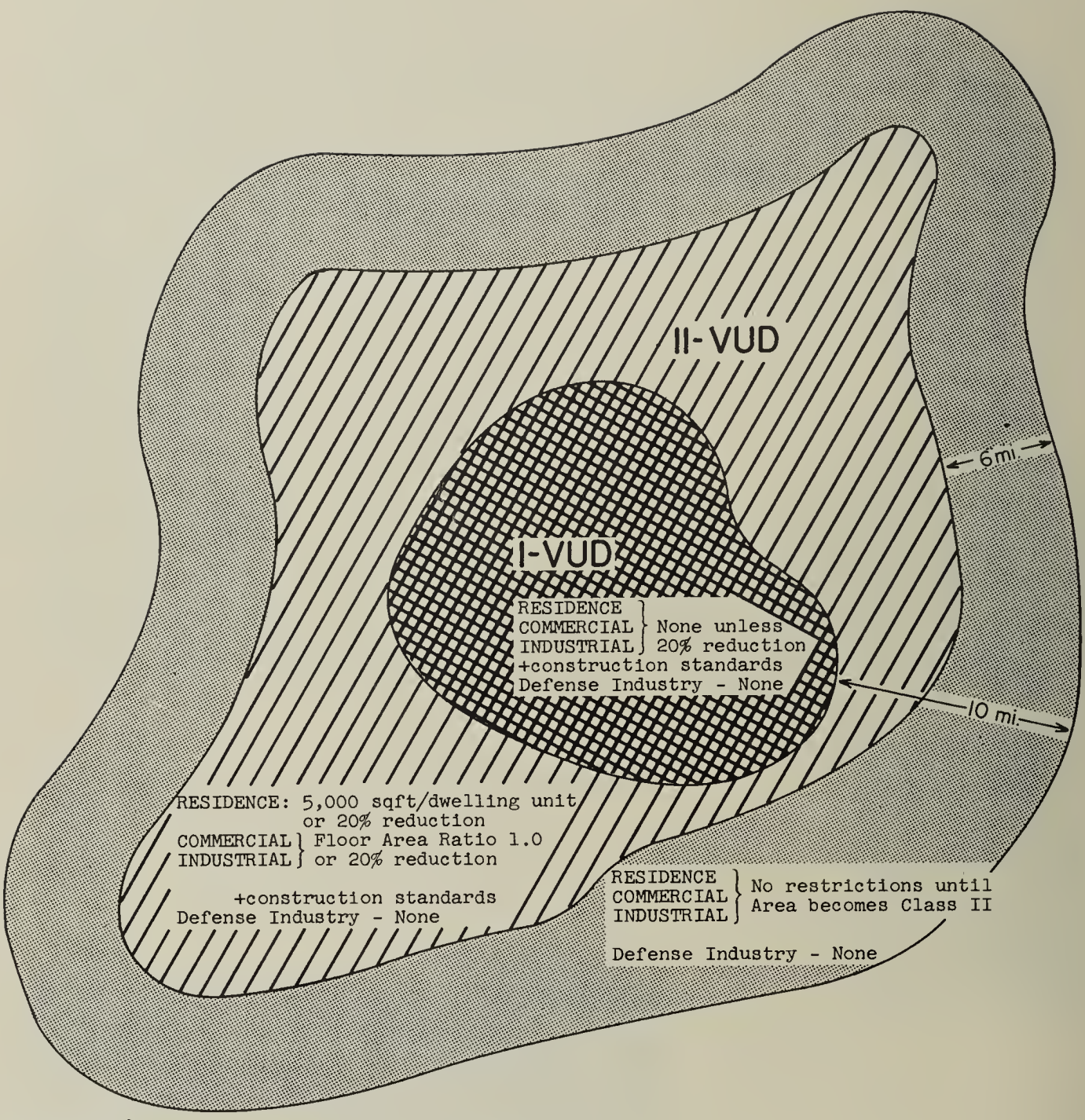
100,000

PERSONS PER SQ. MILE
OF DEVELOPED RES. LAND

MULTI - STORY
APARTMENTS

Chicago City Plan Commission

FIGURE 11



RESIDENCE
COMMERCIAL
INDUSTRIAL
No restrictions until Area becomes Class II

Defense Industry - allowed, until Area comes within 6 miles of Class II or 10 miles of Class I.

FIGURE 12

VULNERABLE URBAN DISTRICTS

Schematic illustration of Class I and Class II Vulnerable Urban Districts and area adjacent to such districts with summary of defense standards for each.

c. Density and Dispersion Standards

PROJECT EAST RIVER has recommended[15] the following minimum density and dispersion standards to guide Federal, state, and local programs of construction and financing of construction in Class I and Class II Vulnerable Urban Districts.

(1) Class I Vulnerable Urban Districts.

No new or additional residential construction should occur in Class I Vulnerable Urban Districts unless the proposed construction replaces an existing development, in which case a 20 per cent reduction in population density should be effected for the total area redeveloped. Open areas (not necessarily contiguous) may be developed in combination with built-up redevelopment areas.

No new or expanded commercial or nondefense supporting industrial construction should take place in Class I Vulnerable Urban Districts unless the proposed development replaces an existing development in which case a 20 per cent reduction in the ratio of floor area to lot area[16] *should be effected for the total area redeveloped.*

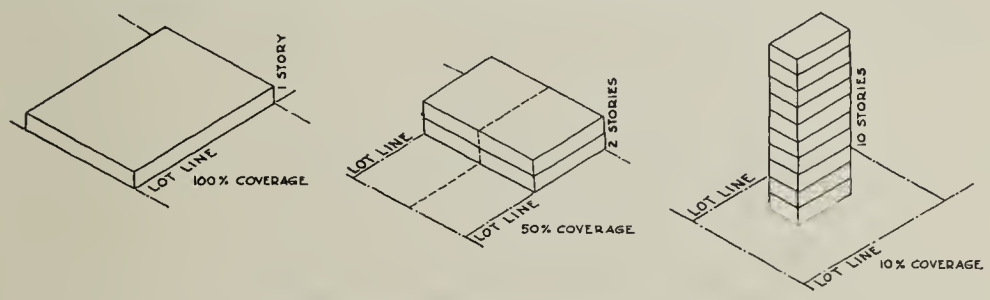


FIGURE 13 FLOOR AREA RATIO

[15] Federal Leadership to Reduce Urban Vulnerability, PROJECT EAST RIVER, Part II-B, June 1952.

[16] Floor area ratio is the relation of total area of floor space above ground in buildings to total lot area. Floor area ratio may be expressed by the following formula:

$$FAR = \frac{G \times S}{L} = B \times S \text{ where}$$

FAR = Floor Area Ratio
G = Ground Area of Building
S = Number of Stories
L = Area of Lot
B = Building coverage (ground area of building divided by area of lot). A building with a floor area ratio of 2.4 could be a 3-story building on 80% coverage, a 6-story building on 40% coverage, an 8-story building on 30% coverage, and so on. Large skyscraper developments such as Rockefeller Center, New York, have a floor area ratio of from 10.0 to 12.0. The average floor area ratio of the mid-Manhattan commercial district is about 5.0. The floor area ratio of the three office buildings being constructed by the Equitable Life Assurance Society in Pittsburgh, Pa., is about 5.0. On the other hand, the average floor area ratio of central districts of the majority of American cities is less than 2.4. Modern shopping centers rarely exceed a floor area ratio of 0.5.

No new or expanded defense-supporting plant should be constructed inside a Class I vulnerable Urban District or within 10 miles of its outer boundary.

This rate of density reduction is not much more than is currently being realized in urban redevelopment projects under the Federal urban redevelopment and slum clearance programs. In order not to retard urban redevelopment through preventing construction on open land in central-city areas, it is proposed that open land development be permitted, provided such development is average with redevelopment so that the combined effect in Class I Districts will be to reduce population density by 20 per cent. For example, buildings housing 800 persons could be built on a vacant site and a redevelopment site if the redevelopment site presently houses 1,000 persons.

(2) Class II Vulnerable Urban Districts.

No new or additional residential construction should take place in a Class II Vulnerable Urban District at a higher density than 5,000 square feet of lot area per dwelling unit unless the proposed construction replaces an existing development of higher density in which case a 20 per cent reduction in density should be effected for the total area developed. Open areas (not necessarily contiguous) may be developed in combination with built-up redevelopment areas.

No new or expanded commercial or non-defense-supporting industrial construction should take place in a Class II Vulnerable Urban District unless the proposed development has a ratio of floor area to lot area of not more than 1.0, or unless the proposed development replaces an existing development of more than a floor area ratio of 1.0, in which case a 20 per cent reduction in the ratio of floor area to lot area should be effected in the total area developed.

No new or expanded defense-supporting plant should be constructed inside a Class II Vulnerable Urban District or within six miles of its outer boundary.

In Class II Vulnerable Urban Districts, standards have been designed to prevent these areas, now borderline target areas, from developing into densely populated or highly industrialized districts.

Federal aid should be available for residential building only when it provides a minimum of 5,000 square feet of lot area per family (except on a redevelopment basis with a 20 per cent density reduction). This will not affect the great bulk of single-family residential construction. A

nation-wide survey in 1948 by the Federal Housing Administration revealed that 98 per cent of all subdivisions filed in the first half of that year were on lots at least 50 feet wide. Lots of less than 5,000 square feet in new subdivisions occurred in only one section of the country (east north central), and they accounted for less than 6 per cent of total subdivisions in this section. Over 60 per cent of the houses reported in this survey were priced at under $9,000. Since 1948, the trend of lot sizes, like house prices, has been upward. For example, the $9,990 house at Levittown, Pennsylvania is being built on a 70-foot-wide lot.

The proposed 5,000 square-foot-per-family standard will discourage single-family residential building on small existing plots and apartment building on vacant land in Class II Districts. Some flexibility in permitting single-family residential construction on existing narrow lots will be necessary as is the case where zoning standards of lot width create the same problem. Possibly the standard should be relaxed to permit Federal mortgage insurance of apartments or public housing at, say, not over 16 families to the net acre, provided they are built to Class I District structural standards. Lacking further analysis as to whether such a relaxed standard would encourage Class II Districts gradually to become Class I Districts, PROJECT EAST RIVER recommends the lower density standard at this time.

The proposed standards limit Federal aid for construction of commercial or non-defense-supporting industrial buildings in Class II Districts with a floor area ratio of more than 1.0 (except on a redevelopment basis with a 20 per cent floor area ratio reduction). This standard may seem high in relation to developments now taking place in some Class II Districts. It is believed, however, that this standard is sufficient for civil defense purposes, and it will tend to hold densities down in parts of Class II Districts nearest to Class I Districts.

The present plant location standard was extended to include areas within six miles of the outer boundary of a Class II District. It may be found advisable to modify this standard when it is tested by a complete mapping of Class II Districts.

Uniform standards for urban density and dispersion, such as those proposed, are necessarily inflexible unless they are made so complex as to be unworkable. Procedures for appeals in specific situations are recommended as an integral part of the control system proposed. It is an important recommendation of PROJECT EAST RIVER that one basis for such appeals should be a locally prepared metropolitan area plan[17]

[17] See page 42 for discussion of metropolitan land-use plans.

which, in the judgement of the appeals agency, produces the results for which the standards are set on a better basis than could be achieved through uniform application of the standards for the vulnerable urban district concerned.

d. Research on Density and Dispersion Standards

The standards outlined above should be improved and refined by extensive research. Research on the effects of atomic attack on structures and the effectiveness of space in reduction of vulnerability is now being sponsored by the Department of Defense, the Atomic Energy Commission, and the Federal Civil Defense Administration. This research tends to be highly compartmentalized because of the high security classification of some phases of the research and the lack of coordination between agencies, units of the same agency, and contractors.

PROJECT EAST RIVER recommends that the National Security Resources Board analyze the research programs now being carried on which are pertinent to the setting of density and dispersion standards and recommend the best means of their coordination. PROJECT EAST RIVER further recommends that the results of this research be translated into terms useful to Federal, state, and municipal agencies concerned with urban development and to metropolitan and local planning authorities through a project of the type already considered by the National Security Resources Board.[18]

Such research should result in a special manual on atomic weapons effects in civil defense planning which contains the following information:

(a) Definitions of damage severity, not necessarily the same as those used by the military;

(b) Explicit data, tables, graphs representing weapons effects in form for use in formulating building codes, zoning ordinances, city and metropolitan plans;

(c) Basic and detailed procedures with tables and charts for for use in local target analysis leading to an assessment of casualties, physical damage, and reduction of target vulnerability.

[18] Proposed outline for the project reduction of Vulnerability of Urban Area Concentrations to Strategic Attack, staff memorandum, National Security Resources Board, March 28, 1952.

Among the problems which must be frankly faced is that of regional relocation. This is a subject very much avoided because of its hot political implications, but it bears hard-headed study which it is getting only in a very limited way as applied to certain highly essential operations.

As the defense factor of spacing is more precisely determined, it can be given greater consideration in the preparation of any particular metropolitan land use plan. In the meantime, there is no need to delay in the preparation of metropolitan land-use plans, since it is less important to make such plans theoretically perfect than to begin the planning process so as to prevent the enlargement or creation of new Class I or Class II Vulnerable Urban Districts.

3. APPLYING THE STANDARDS TO FEDERAL ACTIVITIES

The standards for density and spacing developed above are applicable to a wide range of Federal activities, and when properly used, the standards can have a strong effect in guiding future development so as to reduce urban vulnerability. While industrial and urban expansion is principally a function of private enterprise carried on under state police power regulations, the Federal influence in city building is significant. For example, total building construction in all urban areas in 1950 is reported as amounting to 10.4 billion dollars. During this same year, the Federal Government insured mortgages on building construction in urban areas in the amount of over 3 billion dollars, in addition to the 0.7 billion dollars of contracts it awarded directly for such construction as public housing, schools, public buildings and institutions, and public works.

It is recognized, of course, that Federal financial activities concern nonurban as well as urban areas, that they fluctuate from year to year (and have been cut back in the period of defense build-up), and that the application of urban defense standards may conflict with other priority and program considerations and may also add to construction costs. Nevertheless, direct and indirect Federal operations in urban areas exercise over the years a most important leverage to effect a change from an increasing to a decreasing vulnerability policy.

Following are some of the activities affecting urban growth and development in which the Federal Government participates and which should be guided by defense requirements.

a. Residential Building

The Housing and Home Finance Agency of the Federal Government probably has the greatest influence on the development of

urban areas. The Federal Housing Administration and the Federal National Mortgage Association annually guarantee Federal liability for hundreds of thousands of dwelling units, all of which should be subject to urban defense standards. The Federal Housing Administration's operation is principally one of financing properties of one to four living units per property—mostly single-family detached houses. In 1951 only 16 per cent of Federal Housing Administration financing was for apartment dwellings. Since the great bulk of the commitments of the Federal Housing Administration are for construction outside of the most densely populated sections, the urban defense standards should not reduce unduly the volume of this necessary financing. Certainly, Federal underwriting of speculative building either by the Federal Housing Administration or the Federal National Mortgage Association should be made in a manner that increases the national security and decreases the Federal risk.

The direction of the present urban redevelopment and slum clearance program of the Housing and Home Finance Agency is generally toward reducing the density in central-city areas. This trend should be encouraged, and all future redevelopment construction should be in accord with defense standards. Local plans for urban redevelopment, however, continue at very high densities. For example, a redevelopment plan for one midwestern city calls for more than 500 persons per net acre. Without specific standards the Housing and Home Finance Agency has no basis for disapproving redevelopment projects that increase urban densities in prime target areas.

Many public housing projects, also, are being built at very high population densities. An extension to one public housing project in New York City is reported to accommodate 532 persons per acre. An average of 72 public housing projects in that city are reported as having an average density of 234 persons per acre or more than 125,000 persons per square mile. The densities of Federal public housing projects in Philadelphia, Providence, Chicago, and Detroit range from about 50,000 to more than 125,000 persons per square mile.

Although the cost of land and construction and the problem of tenant relocation are serious deterrents to the development of low-density public housing in central cities, the Federal Government must recognize that defense is handicapped by permitting such densities as those mentioned. The result of such public housing construction can only be to make our cities progressively more vulnerable.

One of the most serious effects of an atomic attack will be the creation of fire storms[19] if the most densely built-up sections of the

[19] See page 61 for discussion of fire problem.

certain central cities are attacked. These areas are typically the worst slum districts of the Nation. Slum clearance in such areas should be given a high priority through public housing and urban redevelopment projects.

PROJECT EAST RIVER recommends that the Federal Civil Defense Administration designate and distribute maps of fire-storm areas. In connection with the redevelopment and public housing projects in the relatively few areas where fire-storm potential exists or where population densities average more than 60,000 persons per square mile, the need of park areas to reduce fire-storm and conflagration possibilities is so urgent that PROJECT EAST RIVER recommends establishment of a Federal program of grants-in-aid.

The activities of the Veterans Administration in home and business financing, as well as hospital construction, should likewise be subject to defense standards. Although veterans hospitals are being built in accordance with standards approved by the Federal Civil Defense Administration, the practice of locating many of these hospitals in highly congested urban centers should be discontinued.

b. Commercial and Industrial Building

The agencies concerned with new defense-plant construction and additions to existing defense plants should comply with the provisions of the National Industrial Dispersion Policy. These agencies include the Department of Defense, the Defense Materials Procurement Agency, the Defense Production Administration, the National Production Authority, the Office of Defense Manpower, and the Reconstruction Finance Corporation. It is recognized that there will be some instances in which the demand for immediate production will conflict with the policy of dispersed location. Dispersion and construction priorities may run squarely into other priorities: manpower, surplus employment areas, power requirements, production targets, and cost considerations. In view of the fact that the bulk of new facilities in the present defense build-up have already been accounted for (with little regard for vulnerability standards), PROJECT EAST RIVER believes that vulnerability standards take precedence over other considerations; the burden of proof should rest upon those who would deviate from the proposed urban defense standards.

It is also urged that the Defense Production Administration and the National Production Authority apply the urban defense standards in the regulation of nondefense construction, particularly in the allotment of critical building materials. In this broad area of control affecting virtually all private construction, the burden of proof should also rest upon those who would deviate from the urban defense standards.

c. Public Works

Federal agencies such as the Post Office Department, the Federal Security Agency, and the General Services Administration should comply with construction and density standards in their building programs. Post Offices, schools of more than one story, hospitals, and Federal office buildings are some of the principal types of construction that should be made bomb-resistant[20]. Federal agencies should not be permitted to lease space in office buildings that do not conform to defense standards.

The Department of Commerce, through the Federal-aid airport program of the Civil Aeronautics Administration, should further proper construction of air terminals and airplane servicing facilities. Through the Bureau of Public Roads, which administers the Federal grants to states for road construction, the program of recommended rubble-free access expressways and circumferential expressways[21] should be advanced. Since Congressional authorization of funds may be required, the Bureau of Public Roads should prepare a program for presentation to Congress.

The proposed urban defense standards should provide minimum requirements for installations erected by the Atomic Energy Commission and for the communities being built at such installations with the aid of the Housing and Home Finance Agency.

The National Security Resources Board should continue its efforts to present to the Congress an acceptable program which will reduce the vulnerability of the metropolitan area of the District of Columbia. The National Security Resources Board should also draft an Executive Order for the President requiring the dispersion of Federal field offices presently located in Class I Vulnerable Urban Districts to the extent that it is practical.

Since late 1950, the President has sought legislative authority and funds to initiate the dispersal of essential functions of the Government from the center of Washington to the periphery of the metropolitan area in Maryland and Virginia. To date, the Congress has not approved this proposal. Its favorable reconsideration is urged, since such a policy would help to relieve congestion in the capital city, would reduce its attractiveness as a remunerative target, would prevent the disruption of those functions considered to be essential in the event of a national emergency, and, finally, would be positive proof of the Federal Government's genuine interest in civil defense.

[20] Bomb resistance standards are discussed on page 54 and following.

[21] See page 37.

With respect to the dispersal of Government functions from the centers of other metropolitan areas, no plans have yet been prepared. The President has requested no legislative authority or funds. With a few exceptions, no effort has been made to disperse existing regional offices or those presently planned as part of the defense mobilization activity. A program to remedy this situation seems worthy of early planning. Slightly in excess of 50 per cent of the total civilian employees of the executive branch are situated within 31 metropolitan areas throughout the country, including Washington, D. C.

d. War Risk Insurance

If a type of Federal war risk insurance is undertaken, the Federal Government should recognize urban defense standards and differing degrees of risk depending on location. No new structures should be insured unless they conform to urban defense standards. Furthermore, premium rates on existing and new insurable structures probably should be graded according to location, with the highest rates set within vulnerable urban districts. It would be a serious mistake if the Federal Government should, by a blanket war risk insurance rate, fail to take cognizance of urban defense standards and differing degrees of risk depending on location. PROJECT EAST RIVER recommends that these possibilities be made the subject of further research.

e. Administration

PROJECT EAST RIVER is aware of many of the administrative difficulties that would arise from the acceptance and implementation of its recommendations. The agencies that must be coordinated have diverse program objectives, some of which conflict with the objectives of the proposed standards. It is recognized that any technical review function carries with it many budgetary and administrative problems, and that no single person or agency has yet succeeded in offering an acceptable solution to the metropolitan area problem.

Yet the urgency of the situation (if that urgency can be communicated to appropriate officials) should reduce the administrative obstacles. PROJECT EAST RIVER has no desire to burden the National Security Resources Board with the administrative details inherent in any technical review process. It does seem necessary, however, to recommend that the direction and coordination of the Federal program, both in terms of the formulation of standards and their implementation, be a primary responsibility of the National Security Resources Board.

It is important that the program be explicitly outlined to the many Federal agencies involved in order that no agency of the Federal Government may hereafter (1) construct buildings or facilities, (2) lease space in new buildings, or (3) give any form of financial aid for construction of building or facilities, unless such buildings or facilities conform to urban defense standards.

It is also important that the National Security Resources Board explicitly outline to those agencies involved in grant-in-aid programs the standards and priorities suggested in the fields of highway construction, slum clearance, park and other open-space development, and shelter construction. It is to be expected that definite policies would be formulated by the appropriate agency or agencies in consultation with the National Security Resources Board, but that the latter would retain a coordinating responsibility.

Administration of urban defense standards should provide for special situations arising from topography, peculiar circumstances, or development of a metropolitan area plan which might make any of these requirements unduly burdensome or unnecessary in the interest of national defense. PROJECT EAST RIVER recommends that the administration of urban defense standards be in the hands of each Federal agency affected, subject to procedures established by the National Security Resources Board, including procedures for appeals in special instances. Metropolitan area plans should be approved by one agency only, and, when approved, the plans should become binding on all Federal agencies in lieu of blanket standards.

Since defense is a paramount factor, it is suggested that the National Security Resources Board consider proper devices for insuring representation of the Federal Civil Defense Administration in the process of formulating or modifying urban defense standards and in the appeals procedures designed to cover special situations that might make any of the requirements unduly burdensome or unnecessary. In addition to coordinating Federal policies and programs in this area, the National Security Resources Board (or a delegated agency) should be authorized to advise state and local governments and private groups concerning specific urban defense standards and their implementation.

4. APPLYING THE STANDARDS TO STATE AND LOCAL ACTIVITIES

a. Public Works

State and municipal (including county) agencies concerned with such construction as public office buildings, hospitals, and schools

should consider the defense advantages of location outside of Class I Vulnerable Urban Districts whenever it is practicable to do so.

b. Highways

State Highways Departments can contribute substantially to the reduction of urban densities by encouraging programs for circumferential highways at least 10 miles from urban centers. Today, most state highway programs, backed by Federal aid, are concentrated on building or improving radial routes into the centers of cities. Coupled with local zoning regulations which permit high-density building in the central areas of cities where land values are highest, these highway programs make further high-density development profitable even though it may increase target attractiveness.

While radial expressways are being given first priority, some circumferential expressways are also being built. The latter tend to encourage new growth outside of central-city areas as the following quotation from the 1951 Annual Report of the Bureau of Public Roads indicates:

"The Northern Circumferential Highway (around Boston), a 28-mile divided highway with controlled access, was very nearly completed. It skirts the congested areas of Boston and forms an important segment of the cross-state highway system which connects with highways in adjoining states. The highway is entirely on new location, sweeping through 10 communities on an arc about 12 miles from downtown Boston. It will serve about 20,000 vehicles a day.

Several defense plants are already being constructed in locations which take advantage of interchanges on the expressway, indicating a trend toward the development of residential and industrial areas in proximity to the new highway." (See figure 14.)

Since the Federal-aid highway funds are to a large degree allocated according to state recommendations and plans, state leadership is essential in construction of new expressways which will assist dispersion within metropolitan areas. PROJECT EAST RIVER recommends that Federal-aid-highway funds be directed more intensively to the provision of circumferential expressways around central metropolitan areas located at least 10 miles from the center of the city. Such expressways will not only act as important by-passes of congested sections through which traffic cannot be moved for some time after an attack, but will also tend to encourage the location of new industries and related development outside of central city areas.

FIGURE 14

CIRCUMFERENTIAL HIGHWAYS INFLUENCE INDUSTRIAL LOCATION

The new circumferential freeway around Boston, Mass., showing its location relative to the congested urban areas.

In addition, the present program of arterial highways through and around central-city areas, should be so guided as to produce arterial highways which will be rubble-free in the event of attack. One of the effects of atomic bombing most difficult to overcome is that of access to densely built city areas immediately after an attack. Arterial highways should be wide enough so that the pavement will not be choked with debris from adjacent buildings.

c. Housing and Urban Redevelopment

State and local housing authorities and municipal urban redevelopment agencies are today responsible for new construction which takes place in the very central positions of prime target areas when population densities are highest. The volume of such activities accumulated over the years is substantial. In New York City, for example, the City Housing Authority's projects in the near future will provide homes for some 110,000 families, or about half a million people, in concentrations which assure the maintenance of Class I Vulnerable Urban Districts for at least two generations.

The forces behind high-density public housing in the Nation's largest and most vulnerable central cities are powerful and deep rooted in customs, preferences, and economics. The largest cities contain and attract to them great numbers of low income groups. Middle and high income families who can afford new housing are increasingly seeking suburban homes, leaving large areas of second-rate and slum housing behind them to be filled immediately by low income in-migrants.

PROJECT EAST RIVER recognizes that there is no one solution for this problem. Progress could be made, however, in reducing residential densities of central cities if the problem were better recognized by state and municipal authorities. Urban redevelopment projects (where land is acquired and prepared for resale at less-than-acquisition costs and developed to an entirely new physical plan), cooperative housing for middle income groups, and extension of municipal housing authority powers to enable public housing for today's central city residents to be built in suburban locations offer ways and means of reversing the trend of continual increase in central city densities.

To achieve any substantial progress in solving this problem it may be necessary to organize urban land acquisition agencies with power to acquire land for redevelopment and development anywhere in an entire metropolitan area. Consideration should also be given to the establishment of authorities which are empowered to build new communities as proposed in the New York Defense Communities bill introduced in the legislature of that state in 1952.

d. Parks and Other Open Space

One of the long-range objectives of defense standards for urban growth and development should be the provision of permanent open space between developed districts.

The retention of open land such as recreation and watershed areas and land devoted to low-density purposes (forests, farming, or urban nonfarm uses) in urban areas is essential in reducing urban vulnerability and preventing new Class II Vulnerable Urban Districts from developing. No solution short of public acquisition of land has yet been found for this problem, which is not solely a civil defense problem. The park movement of the first years of this century, the result of which was the establishment of many of the county and state park systems now in metropolitan areas, is virtually nonexistent today. Lack of large parks is common in most of the rapidly developing suburban areas today. Private golf courses, once a substantial source of open land, are being absorbed for large-scale housing developments.

Civil defense requirements indicate the need of a vigorous revival of park acquisition programs by states and counties. Since the metropolitan areas are expanding rapidly into their surrounding countryside, a program of Federal aid to states, counties, and cities is essential for such areas. The problem of maintaining open space between urban communities is one of the most difficult to solve. Opportunities once missed, as a practical matter, are almost always permanently lost.

e. Administration

Until the Federal agencies act in accordance with defense standards of spacing and construction on a nationwide basis, states and localities will be slow to impose standards which, in some instances, will appear to place them at a competitive disadvantage with other states or other municipalities.

With Federal acceptance of defense standards on any blanket, across-the-board basis, the advantage of organizing metropolitan district planning commissions in order to prepare a land use plan for each metropolitan area will become apparent (especially in areas where topography and other local conditions make blanket standards inappropriate).[22]

Organization of such commissions and delegation of limited planning and land-use control powers to them will require state leader-

[22] See discussion, beginning on page 42.

ship and more local recognition of the metropolitan interdependence of central cities and their suburbs than now exist in most areas. The problem of local administration, however, is not insurmountable, as evidenced by the many metropolitan organizations already created to meet specific inter-community problems.[23] In fact, the creation of metropolitan planning commissions is advisable for reasons of sound peacetime metropolitan growth and development. Civil defense will give added impetus to a movement already underway in several metropolitan areas not only for metropolitan land use planning, but also for zoning and building code revision.

5. APPLYING THE STANDARDS TO PRIVATE DEVELOPMENT

Private investment in urban buildings of all kinds constitutes the greatest force in city growth and development. In terms of building activity in urban areas, about six dollars of private funds are invested for every dollar of public construction.

In the United States, private land developments have been traditionally controlled by state and local laws which protect public safety, health, and welfare. Fire and sanitary codes, multiple dwelling laws, building codes, zoning ordinances, subdivision control procedures, building and occupancy permits are some of the standard types of laws and procedures by which the state and local governments guide and control private developments.

Controls of this kind are not exercised by the Federal Government but are considered as reserved to the states. Clearly the protection of public safety, health, and welfare today should include defense standards of spacing, density, and construction in accordance with the goals for city building as outlined above. Since the urban unit today is often not a single city but a group of two or more municipalities forming a metropolitan area, land use controls should be established on a metropolitan area basis wherever a metropolitan area exists.

It is conceivable that the Federal Government, through the defense power, could justify the exercise of control over land use and buildings to the extent that such control relates to national defense. Should state and local governments fail to exercise control over private development in urban areas in accordance with essential defense standards, Federal action would become necessary.

PROJECT EAST RIVER believes, however, that, if and when the Federal Government conducts its own construction and financing of con-

[23] See discussion, page 43.

struction activities in accordance with defense standards, the states, municipalities, and responsible private investors will follow suit as a matter of public responsibility and private self-interest.

6. METROPOLITAN DISTRICT LAND-USE PLANS

No single set of standards, however helpful as a practical means to reverse the trend of increasing urban vulnerability and to set a ceiling on intensity of development generally, can be more than a stop-gap substitute for a land-use plan of each individual metropolitan area. For this reason, PROJECT EAST RIVER recommends that the standards be modified for metropolitan areas having an approved metropolitan area plan which would make any of the recommended blanket requirements unnecessary in the interest of national defense.

The modern city is rarely contained within the political boundaries of a single municipality. For example, the economic and social unit known generally as New York is in reality a metropolitan area containing over 500 separate municipalities in addition to New York City, which is itself a consolidation of five counties and several former cities and villages. In 1950 the Census Bureau reported that 19 metropolitan areas containing central cities of more than 500,000 population were surrounded by some 2,100 independent suburban municipalities.

During the past 40 years metropolitan area plans have been prepared for specific purposes as the necessity for such plans arose. For example, as central cities outgrew their local water supply sources, metropolitan water supply systems were planned and built. Similarly, metropolitan park plans and metropolitan park and parkway systems developed as a result of recreation needs. Highways, airports, and trunk sewers have also been planned and constructed on a metropolitan basis.

The defense requirements of decongestion of central cities, limitation of densities of new urban developments, and location of new defense-supporting industries now make essential the preparation of metropolitan land-use plans. Such plans are necessary to determine how much any particular central city can be decongested and still perform its proper functions. They are needed to guide the new development in its suburban areas. Techniques now widely applied to individual cities in the preparation of land use plans as the basis for zoning ordinances should be extended to metropolitan land use plans to guide metropolitan development. In a number of metropolitan areas a beginning has already been made on such land use plans by counties and unofficial metropolitan planning agencies.

Land-use planning and control in urban areas have been developed in the United States by individual municipalities to which the states have delegated planning, zoning, and subdivision control powers. PROJECT EAST RIVER recommends that the states, with Federal encouragement and financial aid, if necessary, create and finance metropolitan district planning commissions to prepare, in cooperation with existing local planning authorities, metropolitan land-use plans.[24]

The need for metropolitan land-use planning, now intensified by civil defense requirements, has been recognized for many years. Examples of existing metropolitan planning authorities organized under state laws may be found in the Los Angeles Metropolitan Planning Commission and the Detroit Metropolitan Regional Commission. Recent Federal legislation[25] created the National Capital Regional Planning Council. One of its principal functions is the preparation of a regional land-use plan to enable the Federal Government to fit the development of its own establishment into the general development of not only the District of Columbia but also the parts of Maryland and Virginia adjacent to the District. PROJECT EAST RIVER recommends that metropolitan district-planning commissions be given (by state delegation) power to review local zoning ordinances, local subdivision plans, local building codes and local permits to construct buildings and extend municipal services with whatever limitations on full local authority in these and related regulatory powers over land use as may be appropriate to make metropolitan land-use plans and defense standards of density and construction effective on a metropolitan basis.

Precedents for such controls over local municipal authority by agencies concerned with development of a larger area are not lacking.

[24] These commissions are urgently needed for another vital function relating to civil defense: vulnerability analysis. As developed by FCDA's Tactical Division in field studies of Akron, Ohio and the Boston metropolitan area, this is the procedure in which all the urban features and facilities which would be affected by an atomic attack are put down in a series of maps with metropolitan coverage. The maps are necessary in preparing a realistic disaster operation plan (discussed in Disaster Services and Operations, PROJECT EAST RIVER PART VI), as well as in the actual direction of the operations from the civil defense headquarters. They disclose particularly vulnerable points, such as key links in the water distribution system, which can be protected as a pre-attack measure. Finally, the maps illustrate forcefully the needs in decongestion and defense by space, and so are required in bringing defense considerations properly into the metropolitan land-use plans.

[25] An amendement to the Act of June 6, 1924 relating to the National Capital Park and Planning Commission, Public Law 592, 82nd Congress (1952).

In Nassau County, New York, the County Public Works Department (and in some situation the County Planning Commission) and in all New Jersey counties the County Planning Commission today review subdivisions before final approval by any local municipality in the county concerned. Throughout New York State subdivisions must also be approved by the State Department of Public Health or designated local health authorities.

It should be recognized that defense requirements will sometimes affect metropolitan land-use plans by adding requirements to urban development which differ from what might be called normal metropolitan growth and development. For example, certain categories of industry (defense-supporting plants) should in the future be located outside of central districts for reasons of defense rather than reasons of land economics alone.

PROJECT EAST RIVER holds no brief for any particular pattern of metropolitan development. Defense criteria available to this study did not dictate a choice between low-density continuous development and any of the possible patterns into which metropolitan areas might be organized by comprehensive planning. Metropolitan land-use plans will undoubtedly vary one from another depending on topography, existing transportation systems, land economics, social habits, preferences of the residents of different sections of the country, and many other factors.

Defense requirements of urban development must be supplied by the Federal Government to metropolitan planning authorities if intelligent metropolitan land-use plans are to be drawn up and made effective. If land should be reserved for suburban parks, farm lands, or other protective belts, both metropolitan planning commissions and the public must be convinced that the setting aside of such open space from normal development is essential to security. Similarly, to open up congested central cities, with the great capital outlay involved and inevitable local opposition to be overcome, requires an authoritative appraisal of the security benefits derived from open space. For example, if expressways should be constructed through congested city areas to serve as rubble-free access roads and to decrease vulnerability from fire, the security benefits must be made clear.

The plans for immediately developing this program should be based on the guiding principles that central cities of highest concentrations of people and industry should gradually be decongested; that new developments in outlying areas should not exceed about 8,000 persons per gross square mile; that metropolitan development should not be susceptible to fire storms or large scale conflagrations unchecked by open space; and that a maximum of alternate transportation and utility facilities be achieved.

7. DISPERSION AND MUNICIPAL FINANCES

Closely tied in with the central-city density problem is the municipal tax base problem. Federal, state, and local taxation has a profound effect on urban developments, arising from the fact that municipalities can raise revenue only from the land within their boundaries and the activities that take place on this land. To gain revenue it is necessary for each municipality to increase the assessed value of its land and the volume of business carried on within its city limits. This involves more intensive development, more concentration of people and industry, increased city density, and added vulnerability. In this connection, it is interesting to note that local municipal revenue totals more than state revenue each year (exclusive of duplicating intergovernmental aid).

State and Federal Governments are increasingly active as tax collectors from sources beyond the reach of municipalities. Since a single municipality in a metropolitan area has no longer an adequate revenue area from which to collect its taxes, state and Federal aid to municipalities is increasing. In 1949 aid from state and Federal governments represented one-fifth of all revenue of cities of over 25,000 population. Expenditures for this purpose rose from 1.8 billion dollars in 1942 to 4 billion in 1950—a rise of 135 per cent. State aid to local government amounted to approximately 37 per cent of state revenue of all kinds (including Federal grants but excluding unemployment compensation) according to the Governors' Conference Committee on Intergovernmental Relations. The effects of this trend require careful analysis to determine how significant the factor of taxation is in forcing municipalities to encourage intensive developments and whether Federal and state local-aid policies could be shaped to make decongestion and dispersion more palatable to municipal officials.

The use of urban defense standards will bring increasing financial difficulties to municipalities which contain concentrated urban development or which may be subjected to new growth through operation of the standards. To meet these difficulties, there must be a readjustment in the present systems of taxing and spending by the local, state, and Federal governments.

At first glance it might appear that the central cities would be the portions of metropolitan areas hardest hit by application of urban defense standards which restrict further concentrations. Further analysis suggests, however, that the cities, counties, or townships which contain the suburban fringe and the open country beyond may feel the heaviest impact of additional financial problems, as they seek to acquire community facilities and services in proportion to new residential, commercial, and industrial development.

During recent years, the Hoover Commission, the United States Conference of Mayors, the Governors' Conference, the Congress, and many other organized groups have been interested in the problem of adjusting Federal-state-local functional and fiscal relationships. PROJECT EAST RIVER recommends that the National Security Resources Board, in order to further the application of urban defense standards, give its strongest support to the proposal for a National Commission on Intergovernmental Relations, or to any alternative proposal which promises solutions to the urban financial problems arising out of defense requirements.

III REDUCTION OF URBAN VULNERABILITY BY STRUCTURAL PROTECTION

1. STRUCTURAL PROTECTION: DEFINITION AND IMPORTANCE

This section is concerned with the provision of shelter, whether in special shelters, in existing buildings, or in such structures as subways or tunnels; and with measures to make the buildings themselves more resistant to the effects of atomic weapons. Fire, chemical, biological, and radiation effects are involved as well as blast. Although one of the most effective fire prevention measures is adequate spacing of structures, for reasons of convenience the discussion of fire control is included in this section.

It is estimated that a comprehensive program of structural protection could reduce casualties in the event of an atomic attack by as much as 75 per cent[26], with the expenditure of a relatively small percentage of the Nation's manpower, materials, and money. A total of 1.8 billion dollars was requested for shelter purposes in 1951 and again in 1952 by the Federal Civil Defense Administration. This amount may have been excessive from indications in recent studies in New York and Boston.[27] A more limited program of marking existing shelter areas and making minor alterations to existing structures could perhaps accomplish almost as good results. As a comparison for the order of magnitude of expenditure on a shelter program it should be pointed out that the replacement cost for physical damage from a single Hiroshima-type atomic bomb used over Boston is estimated at 2 billion dollars.

It is generally agreed that attack against the home front will be an important aspect of any future war. Conversely, the execution of a reasonably comprehensive program of structural protection may be a significant deterrent to future enemy attack. Such a program therefore becomes a necessary part of normal governmental responsibility, and basic responsibility clearly rests upon the Federal Government to establish the bases in broad planning, to delineate critical target areas in some order of priority, and within these areas to provide funds through which a reasonable level of protection may be provided for every citizen.

[26] See footnote page 15.

[27] See pages 87 and 88.

2. THE GOALS OF STRUCTURAL PROTECTION

a. A Reasonable Level of Protection

Absolute protection against modern attack is not generally possible, and would not be within our economic means if it were. But everyone within target areas can be provided markedly improved protection in selected areas of existing buildings, in improved buildings, or in new buildings. Although the principles and techniques for design of buildings to resist atomic attack are still under development, there has been a surprising agreement on the level of relative security that may reasonably be provided, starting with the statement of the Atomic Energy Commission[28] that "a distance of about a half a mile from ground zero would be a reasonable compromise for the planning of general protective measures." This is generally considered to mean providing the equivalent of 12 inches of reinforced concrete in locations away from the exposed surfaces of the building.

A compromise figure of this sort runs the risk of displeasing both the experts, who know how inadequate it is, and the public, who doubt that even this much protection is necessary. It has been proposed on a number of occasions, however, by those who understand the variety of weapons which may be expected over the course of the next few decades and the limitations of our economy. A recent study of mathematical probabilities covering a wide range of assumptions regarding weapons and conditions of attack tended to support a figure of this sort,[29] within a few inches either way, for aimed bombs. When random aiming was assumed, the probability analysis gave far more specific responses, and pointed to an optimum thickness of only 10 inches of reinforced concrete for the whole range of assumed weapons and forms of attack.

In fact, random aiming may be a very reasonable assumption over the life of buildings and communities now being planned. Recent vulnerability studies of the Boston metropolitan region conducted by the Federal Civil Defense Administration indicate that typical cities are likely to offer a wide dispersal of profitable aiming points around the central core. Furthermore, the possibility of enemy development of guided atomic missiles within the next few years cannot be discounted. Such weapons would not be suited to precise aiming. It is entirely reasonable, therefore,

[28] Atomic Energy Commission, THE EFFECTS OF ATOMIC WEAPONS, U. S. Government Printing Office, 1950, page 375.

[29] Lehigh University, Institute of Research, Investigation and Design of Air Raid Shelters, Report No. 8, Volumes 1 and 2, ANALYTICAL METHOD FOR ESTABLISHING A SHELTER PROGRAM, October 1951. For discussion of Lehigh report see page 95.

to move ahead at once on the basis of providing a standard of relative security in the form of structural protection the equivalent of 12 inches of reinforced concrete, plus added shielding against radiation in the form of wall, roof, and floor structures, without waiting until every technical detail and a complete method of analysis are available.

The responsibility of the Government for the provision of structural protection is both short-range and long-range. A significant reduction in the scale of the problem can be made by intelligent planning of the new structures to be erected over the course of a number of years, but the immediate situation cannot be disregarded. In the present armament race, a determined enemy may be in a position to launch a saturation attack on the United States within a few years, and an effective program of finding the most effective available shelter must be carried out before that time if our preparedness is to serve as a deterrent. This means marking shelter space in buildings that already meet reasonable standards, and adding support or reinforcement in buildings that can be altered to meet the standards with little additional effort. In certain critical locations, it means the addition of more substantial construction, as the result of careful engineering surveys of needs.

Such an effort should be undertaken at once; it will not be wasted. Future changes in the character of urban development as well as a possible program of decongestion and defense by space will necessarily operate slowly enough so that sound shelter provided in present urban areas will remain useful for years, against the new generators of blast and fire as well as the old high explosive and incendiary weapons. The cost of an adequate program cannot be figured with accuracy in advance of a detailed survey of shelter needs and resources, but it is not likely to exceed the Federal Civil Defense Administration's estimate of 1.8 billion dollars and it may be substantially less.

b. Reduction of the Numbers to be Protected

The cumulative effect of a policy of protection by space, such as is described above, will help substantially in the long run to reduce the number of those requiring protective construction. Figure 15 shows the character of the savings inherent in preventing further congestion in target areas and the increased savings available if measures can be taken to compel a gradual decrease in central congestion.

In the future, when civil defense organizations have been filled out and trained to take a major role in national defense planning, the responsible director of civil defense in a large city may well proclaim periods of unusual risk of attack, during which certain specific groups of people

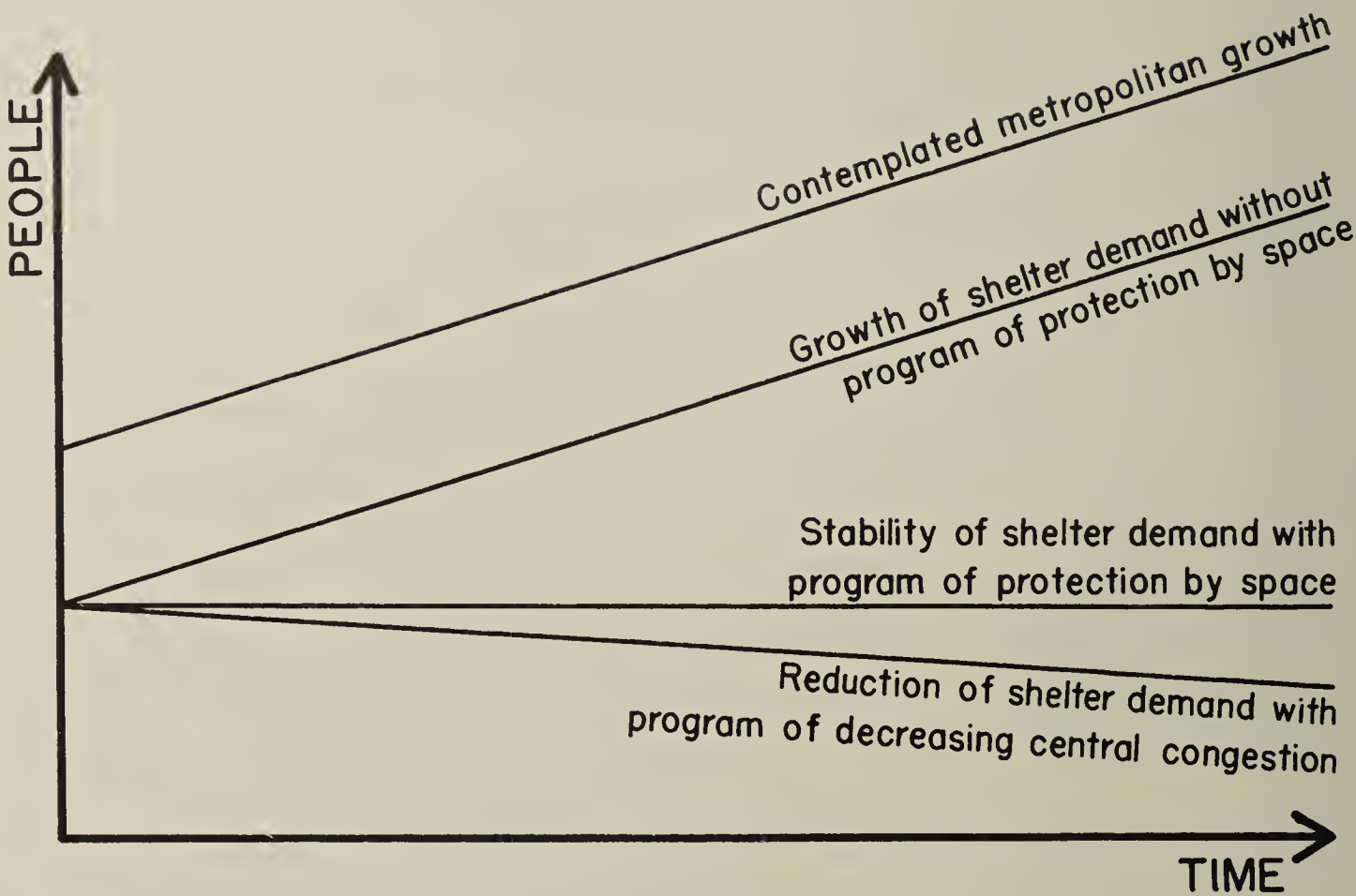

PEOPLE
Contemplated metropolitan growth
Growth of shelter demand without program of protection by space
Stability of shelter demand with program of protection by space
Reduction of shelter demand with program of decreasing central congestion
TIME

FIGURE 15
Shelter Demand

will be advised—or possibly even ordered—to leave the city to stay with relatives or friends according to pre-arranged plan. This is a form of strategic pre-attack evacuation which may simplify substantially the problems of civil defense, including those of shelter supply. Every such opportunity to reduce expenditures for structural protection must be given serious consideration in long-range planning.

At the present time neither the civil nor the military defense of the country is well enough organized for reliance upon such measures, and shelter programs must include everyone likely to be in a target area when it is attacked.

It is certain that a voluntary movement away from the centers of the largest cities will grow rapidly following the outbreak of significant new hostilities in any part of the world, and will swell to a flood

following an enemy attack on the United States or its possessions. Planners of protection measures must give as much attention to these possible preventive steps as to the more usual steps of disaster relief. Survey reports indicate that even with the best medical attention a significant number of Japanese would have died under A-bombing. Defense by space and by structural protection would have been many times as effective.

Measures to prevent and even reduce congestion can do only a part of the job, for key production workers must stay at their posts, wasteful movement in and out of cities must be prevented, and panic must be avoided. Still these measures under sound planning and direction can make a sizeable contribution to the accomplishment of civilian protection, and information is needed on their practical extent. In any event, the availability of such measures should have an effect on the establishment of priorities for shelter construction.

c. Maximum Use of Existing Structures

During the present period in which some quick measure of protection should be found for everyone in target cities, maximum use must be made of existing buildings and of such other existing shelter as can be found in the form of tunnels, subways, etc. Most state and city civil defense organizations have no funds for shelter construction, and must concentrate on finding a location to which each person may go for protection during an attack. It is recognized that many of the areas so selected will not provide shelter to acceptable standards, particularly in the case of buildings of wall-bearing construction. Nevertheless, those responsible for the protection of the civil population cannot wait until standards are met. They must designate shelter locations for all, confident that they may thus increase substantially the number who will survive a surprise attack. This process is now under way in most target cities, and it is the logical first step in the protective construction program. Locations so marked will have to serve the public as best available shelters for a period of about two years before funds can be made available and shelters meeting adequate standards and in sufficient quantity can be provided.

Even when funds are available they will not be unlimited, and maximum use will still be made of existing structures. PROJECT EAST RIVER is assuming that within two years civil defense directors may count on at least one hour's yellow warning, which will be public, and at least fifteen minutes' red warning of enemy attack. If much more warning is available, it is assumed that it will be treated in the nature of news, rather than specific warning. It is our belief that this warning period may reduce the load on shelter areas and increase the chances of some form of pre-attack evacuation, but that it will leave substantially unchanged the plan-

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ning policy of locating shelter areas within five to fifteen minutes of those to be sheltered if possible and preferably locating them within the same building.

In the long run, new types of weapons may seriously alter the possibilities of advance warning, and even at the present time, it is important to avoid panic, maintain productivity, and offer a manageable task to those who must direct people to shelter areas. Furthermore, no expert expects that attacks in any future war will be longer in duration than two to four hours or will be repeated night after night as was the London blitz of the last war. All of these factors favor the use of shelter areas in existing buildings, and all oppose the development of massive communal shelters of the type built in Germany during the last war. Except for unusual locations where existing buildings are low and of very poor construction, considerations of cost seem to rule out even the small communal shelters widely used during the last war by the British.

Even in the central areas of key cities, massive construction will rarely be justified, and in most residential areas reliance will be placed on improvised shelter in the form of reinforced basements, shallow dugouts, and simple structures suited to individual means. In later stages, a protection program may call for the abandonment of areas so provided in favor of improved locations or constructions, but for the present, the first concentration of a construction program must be on the improvement of existing shelter areas to meet adequate protection standards.

d. Maximum Use of New Structures

Very important for future planning will be the shelter areas provided in the course of construction of new buildings. The shelter standard of six square feet per person, proposed by the Federal Civil Defense Administration, is accepted by PROJECT EAST RIVER, although it is more than some standards suggested by other governments. For an attack which continues several hours such shelters will prove none too large, and for a brief attack they may accommodate some of the people on nearby streets as well as those normally in the building at its peak hours. It is also suggested that shelters be located below the top floor of the building to provide overhead radiation protection. In most cases, however, a designer will provide for shelter areas by strengthening the walls of elevator or other corridors and using them to carry the largest part of the structural load. When reinforced concrete shear walls are used in this way, it is a simple matter to add overhead mass, and the use of the top floor for shelter purposes becomes entirely feasible. Shelter areas so incorporated into new buildings can be provided for little or no additional building cost. (See figure 16.)

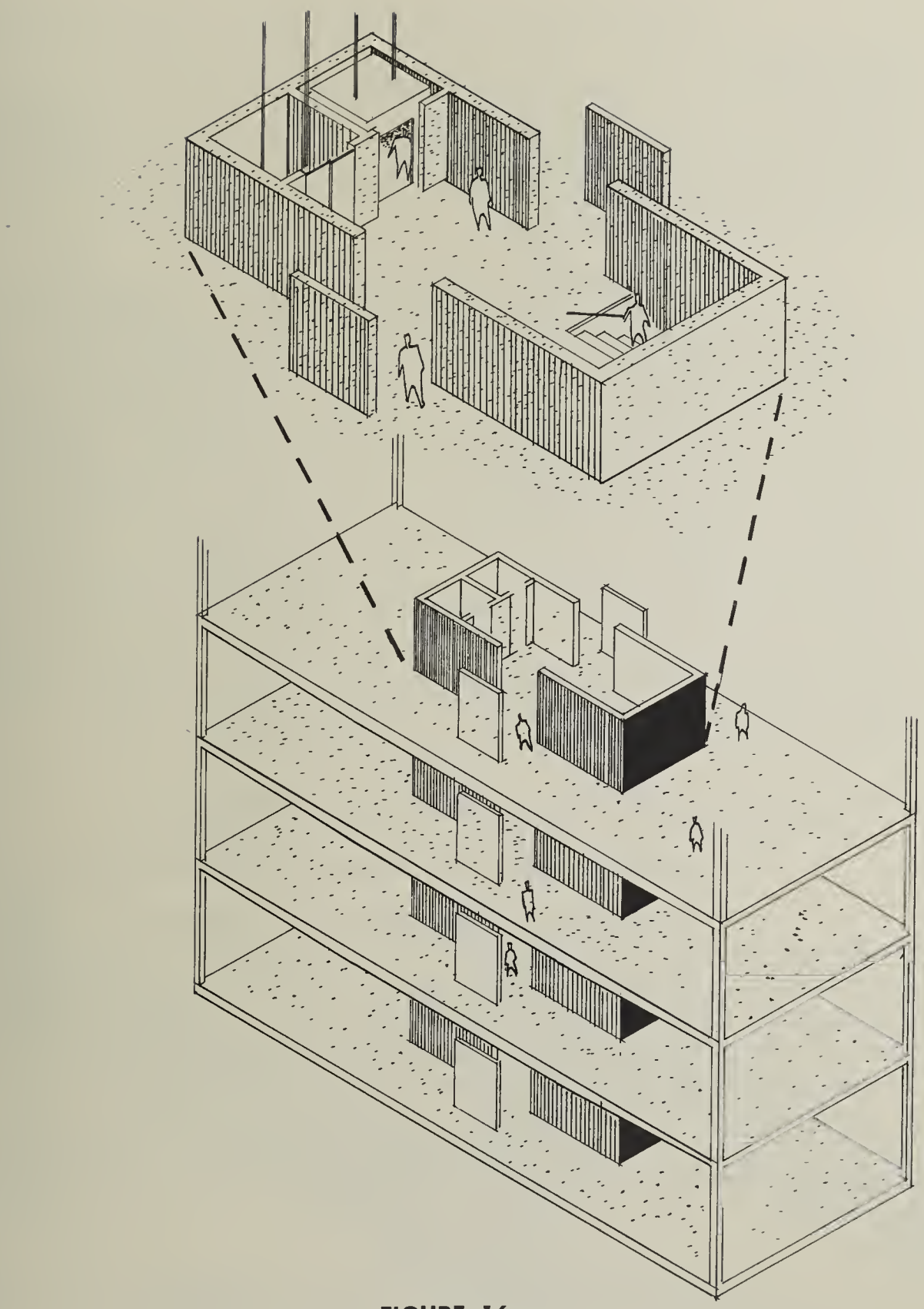


FIGURE 16

SHELTERS FOR NEW BUILDINGS

Diagramatic sketch of a building providing a central shelter area through design of the structure itself.

It is also possible with small expense to add substantially to the resistance of the building itself to blast loads by requiring that the framing members of all new buildings be tied together to form a structure which will resist all loadings as a continuous unit. In the case of reinforced concrete structures, this would add no cost, and in the case of steel frame structures, the added cost would be less than one per cent of the structural cost. (See figure 17.)

The addition of protective constructive measures of this sort in all new buildings in target areas will become, over the course of time, the means of adding a substantial amount of inexpensive protection. Construction expenditures currently run close to thirty billion dollars annually, of which two-thirds are for building construction. Although in many major cities the rate of replacement of central buildings may be slow, the cumulative effect of this addition to the over-all shelter supply could be very large, as is shown in figure 18. It should be required, therefore, in building codes and in the standards of financial agencies and other enforcement groups, that every new building in target areas provide shelter areas for those on the premises at the normal peak load, and certain simple measures of construction should be required to improve the resistance of the building itself to blast and to the initiation or spread of fire. It may be feasible, furthermore, to require owners of existing buildings to provide shelter for the occupants, where the cost of alterations for this purpose are low.

3. STANDARDS REQUIRED IN STRUCTURAL PROTECTION

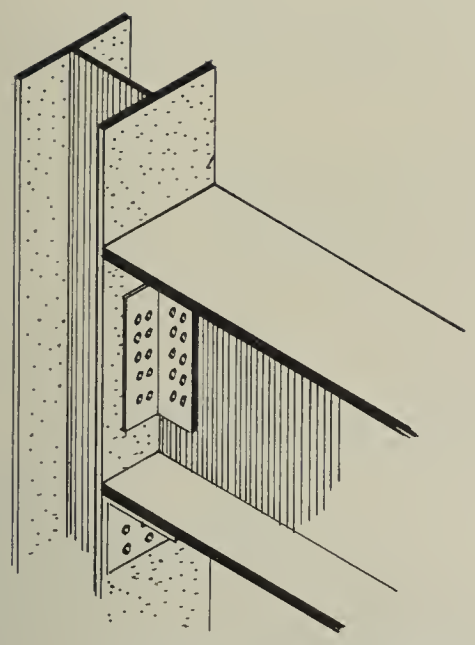
a. Building Standards for Blast and Radiation Protection

A detailed discussion of standards suggested for code purposes was presented in the Interim Report of PROJECT EAST RIVER entitled, "Federal Leadership to Reduce Urban Vulnerability." These standards were to be applied to construction sponsored by the Federal Government in two classes of Vulnerable Urban Districts. As applied to Class I Vulnerable Urban Districts, they may be summarized as follows:

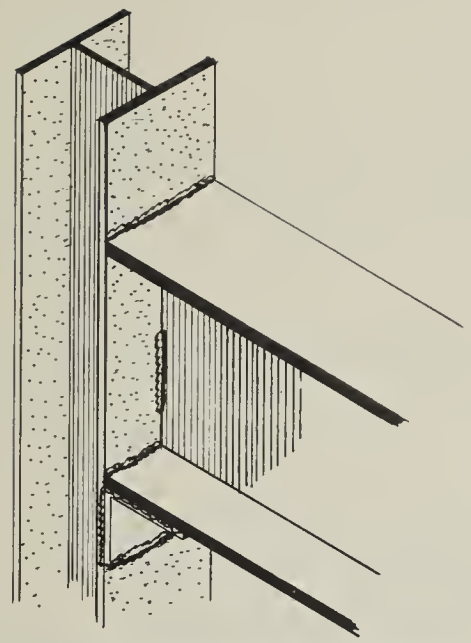
(1) Shelter areas should be provided equivalent to a minimum of six square feet per person in each building at its normal peak population.

(2) Shelter areas should be located below the top floor of each building unless sufficient overhead radiation protection can be other wise obtained.

(3) Shelter areas should be surrounded on all sides by the equivalent of a minimum of 12 inches of reinforced concrete.



NORMAL STEEL FRAME



WELDED STEEL FRAME

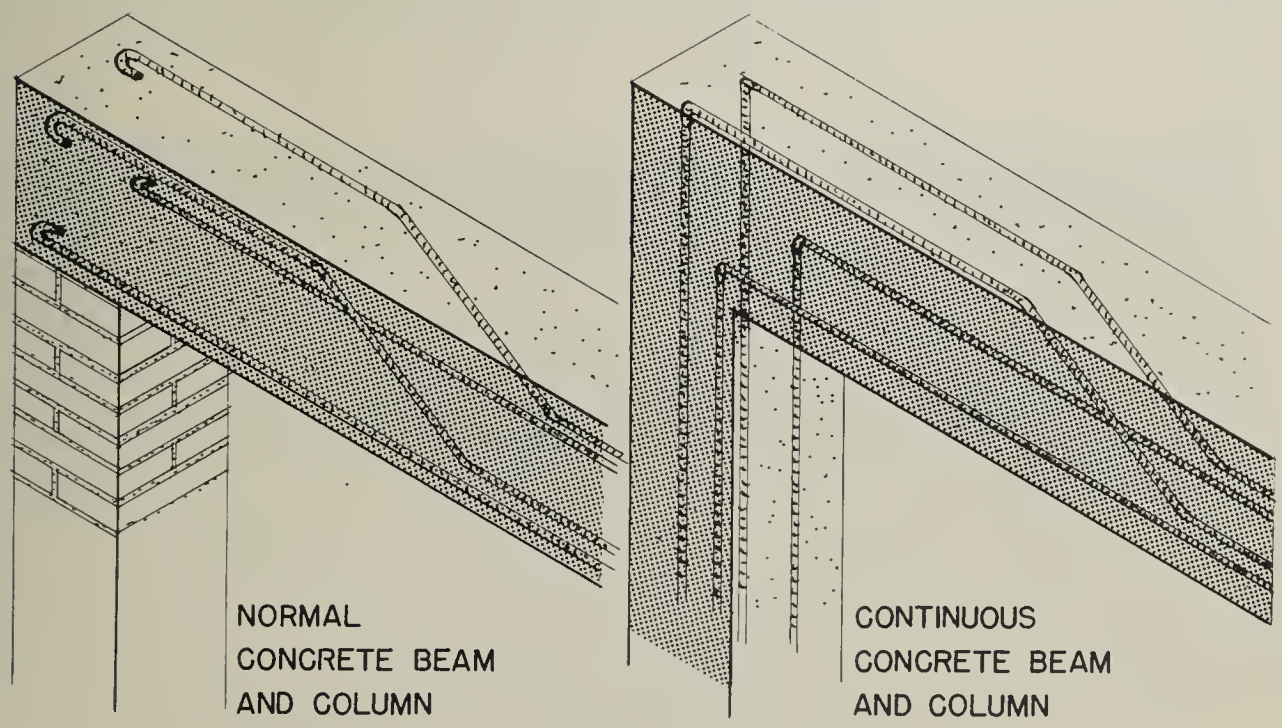


FIGURE 17

ADDED STRENGTH WITH LITTLE OR NO ADDED COST

Tying framing members to form a continuous structure.

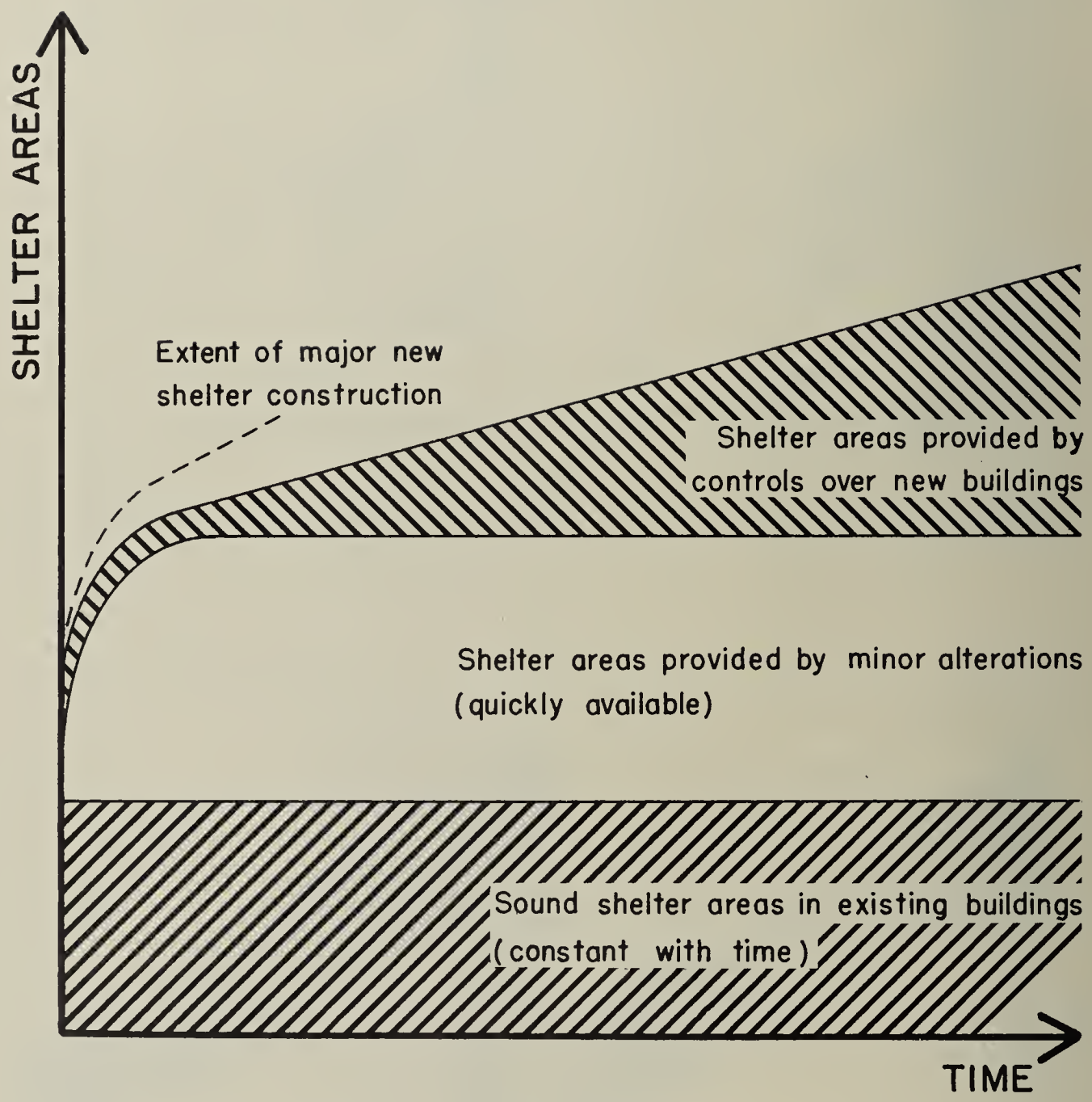

SHELTER AREAS
Extent of major new shelter construction
Shelter areas provided by controls over new buildings
Shelter areas provided by minor alterations (quickly available)
Sound shelter areas in existing buildings (constant with time)
TIME

FIGURE 18
Shelter Supply

(4) In all steel frame or reinforced concrete buildings the framing members should be tied together to form a structure which will resist all loadings as a continuous unit.

(5) No wall-bearing buildings should be erected. (The term wall-bearing is used in its conventional sense to cover the typical masonry-baring wall. Properly designed shear wall construction, for example, is not included in this provision.)

(6) All institutional and public buildings and all buildings with a ratio of floor area to lot area of more than 2.4 [30] should have design live loads for blast resistance as follows:

BUILDING ELEMENT	EQUIVALENT STATIC LOAD (for use in design in place of actual dynamic load from blast effect; see figure 19)
Structure as a whole (design of framing, vertical and horizontal bracing, footings, etc.)	90 lbs. per square foot on vertical surfaces; 70 lbs. per square foot downward on roof
Roof and floors (except exterior of shelter area)	70 lbs. per square foot from either side (with design load only in place)
Walls (interior and exterior except exterior of shelter area)	150 lbs. per square foot from either side
Slab covering stairwell or elevator shaft	150 lbs. per square foot downward

Structural requirements in Class II Vulnerable Urban Districts are the same as those in Class I except that:

(1) In residential construction, where each dwelling unit opens directly to the ground, shelter areas need not be provided.

(2) Wall-bearing buildings may be built three stories or less in height.

In addition, the recommendation was made that all new or additions to existing institutional and public buildings of more than one story in height located in standard metropolitan areas surrounding Vulnerable Urban Districts be constructed to the structural and fire standards of a Class I Vulnerable Urban District. Standards of this character should be applied to major new buildings over a wide range of locations. Within the life of such buildings major changes in weapons technology are certain, and whole metropolitan areas may become the targets for remotely controlled missiles for which aiming cannot be precise.

[30] See definition page 27.

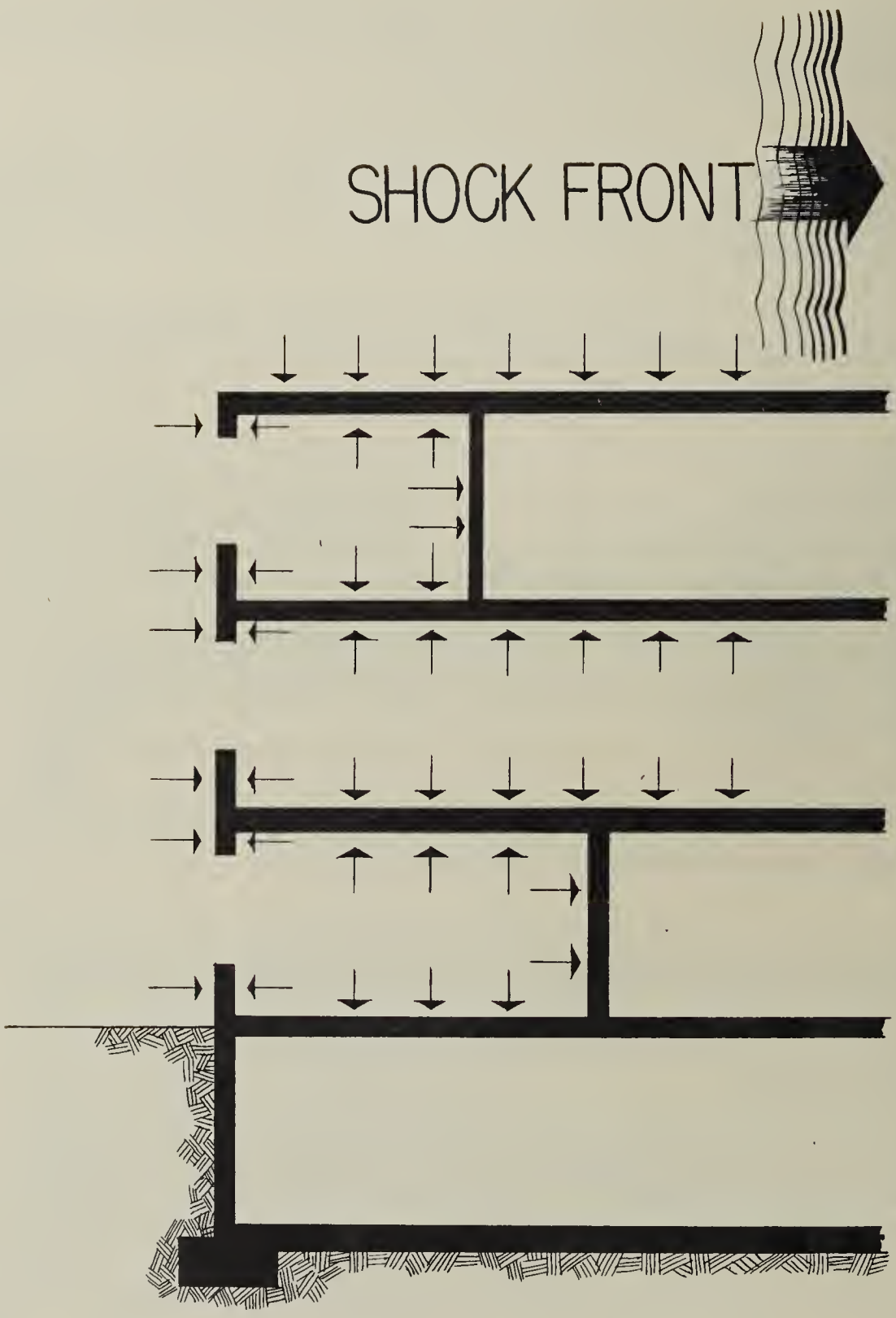


FIGURE 19
DYNAMIC LOAD FROM BLAST
Schematic diagram of pressures acting on a structure subjected to blast.

The added structural strength which is called for by the standards above in new major buildings and in new public or institutional buildings is suggested because these are not only the buildings most likely to be sought out by the public during an attack but also those most needed after the attack for the operations of disaster relief and rehabilitation. The standards are those suggested by the Federal Civil Defense Administration in its INTERIM GUIDE FOR THE DESIGN OF BUILDINGS EXPOSED TO ATOMIC ATTACK.[31] In the case of several proposed Federal buildings, for which calculations were made at the request of the Federal Civil Defense Administration, it was shown that full compliance with these standards would add less than 3 per cent to the over-all building cost. Engineering studies of other building types indicate that additions to structural cost from the application of the standards may vary between 10 and 20 per cent. Since structural cost is ordinarily between 30 and 35 per cent of the total building cost, this means that the proposed additions to total building cost will rarely exceed five per cent.

To require a higher level of protective construction is likely to prove economically impractical. Tremendous advantages can be gained in terms of protection by making changes which add little to normal construction cost; beyond the first five per cent of added cost, little gain in protection is made despite tremendous increases in cost. This is shown graphically in figure 20, which represents a wide range of building and weapon situations and is therefore not prepared to a specific scale. It indicates, however, that a five per cent additional cost can strengthen a building so that it will offer protection substantially closer to the point of detonation, whereas additional expenditure of very large proportions would add little more. People in the building could be protected in special shelter areas, and only buildings of great strategic importance would require strengthening to resist the effects of nearby bombs. In most cases, location at a distance from the target area will prove a more economical method of providing this resistance than a high degree of protective construction.

It has been pointed out that primary reliance for protective construction should be placed upon the use or adaptation of existing buildings and upon the requirement of protective measures in new buildings. It follows that special additional shelter structures will be justified only in a period of imminent attack when substantial resources can be spared for the purpose of rapidly increasing the national defenses. This is shown in figure 18. If the attack can be deferred, the cumulative effect of making alterations to existing structures and adding sound new structures will rapidly supply sound shelter areas. Meanwhile, with limited resources, shelter areas must be marked wherever possible, even though they may not be up to the standards that will be realized at low cost in the future.

[31] Released July 6, 1952.

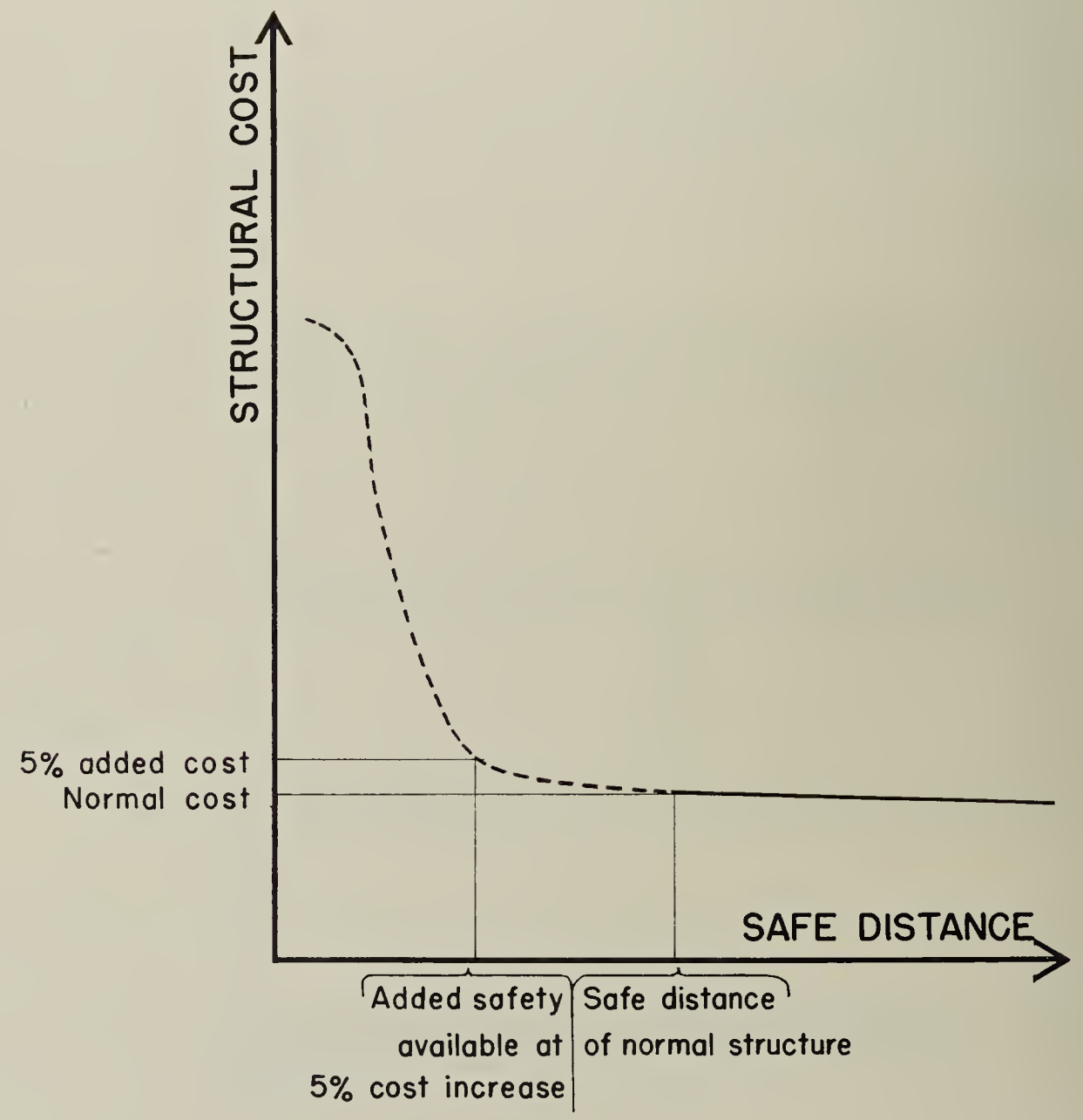


FIGURE 20

ADDED SAFETY AT 5 PER CENT COST INCREASE

Relationship of structural cost to a safe distance for a constant level of protection.

In any case, a thorough evaluation of the risk of enemy attack during the life of future buildings justifies the public in requiring that inexpensive preventive measures be taken during construction. These measures should include the reduction of fire risks as well as blast and radiation risks. And the Federal Government should lead the way and require that such measures be taken henceforth in the design of structures aided by public funds.

b. Fire Protection Standards

Fire standards recommended for Class I Vulnerable Urban Districts in the Interim Report of PROJECT EAST RIVER entitled "Federal Leadership to Reduce Urban Vulnerability" may be summarized as follows:

(1) Maximum area of plot which may be used for any type of dwelling unit should be 30 per cent.

(2) Roofs of all structures should be covered with material which will resist fire spread.

(3) No combustible construction should be permitted.

(4) Top fire loading limits should be 40,000 B.t.u. per square foot in unprotected steel frame buildings or 80,000 in one-hour protected buildings; fire-resistive buildings should have fire resistance proportional to the fire loading.

(5) Horizontal compartmentation by fire walls should be provided for each 1,600,000,000 B.t.u. fire load.

(6) Automatic sprinkler protection should be installed when fire loading is over 20,000 B.t.u. per square foot in unprotected steel frame buildings or over 40,000 in one-hour protected or fire-resistive buildings. Sufficient water supply should be stored on the premises to feed 25 per cent of all the sprinkler heads in any one building or compartment for one hour.

(7) No window frames or window trim should be made of wood.

Fire provisions in Class II Vulnerable Urban Districts are the same as those in Class I except that combustible residential construction is permitted, not to exceed a maximum total bulk for each structure of 150,000 cubic feet, a maximum height of three stories or maximum ground floor area of 10,000 square feet (one-story buildings), 5,000 square feet (two-story buildings), 2,500 square feet (three-story buildings).

Probably the most serious urban defense hazard is that of fire. The A-bomb exposes a city to heat radiated from a huge ball of fire. The danger of widespread fire destruction in cities will continue until a sufficient percentage of existing combustible buildings burn down, are removed, or are protected. For future fire protection there is no alternative to limiting the size of buildings and restricting the total area of ground coverage. Where ratio of roof coverage to ground area exceeds 20 per cent over an area of at least one square mile, the mass effects of a fire storm can be produced in combustible areas. This would result if many small fires merge to form one gigantic blaze, drawing towards it along the ground winds of gale velocity from all directions, and burning out completely every bit of combustible material in the firestorm area. When the number of fires is small, large fires can also develop, not of the fire storm pattern, but simply sweeping conflagrations. (See figure 21.)

It is recommended that the maximum area of any residential lot which may be used for any type of dwelling be established at 30 per cent. If this figure is multiplied by 70 per cent (allowing 30 per cent for streets and other open spaces) it corresponds with 20 per cent gross neighborhood coverage. Just as future buildings should provide shelters against blast, so should they reduce fire risks. In this provision, the advantages gained are as important in peacetime as in wartime.

Fire risks are in large part a function of congestion, and measures taken to reduce congestion also reduce the fire risk. In the crowded areas which are susceptible to fire storms, however, to reduce densities to reasonable dimensions or to create lanes or breaks which will have any substantial effect on the development of major fires would be inordinately expensive. In the course of time, measures of defense by space will have their effect, but in the meantime, people in these danger areas can be given adequate protection against blast and radiation for a very small cost. In a study by PROJECT EAST RIVER in mid-Manhattan,[32] shelter of adequate standards could be provided for as little as $5 per person over substantial areas. Against the fire risks, there is little alternative to insistence upon good standards of housekeeping and of fire prevention and a thorough preparation to fight the fires that will take place.

Most effective in the long run will be the insistence that sound fire standards be provided and maintained in all new buildings to be built in target areas. A summary of the fire standards proposed by PROJECT EAST RIVER for buildings sponsored by the Federal Government has been given above. A detailed discussion of this subject is presented here.

[32] See Appendix V-A.

FROM THE AIR

FROM THE STREET

FIGURE 21

A TYPICAL FIRE STORM AREA

The A-bomb exposes a city to a tremendous flash of heat. In view of this danger, numerous present practices regarding storage of material and construction of buildings must be modified if fire resistance is to be improved.

(1) Outdoor Storage

Outdoor storage includes lumber yards, coal yards and depots, automobile parking areas, railroad yards and numerous industrial storage yards. Any of these may be as significant as groups of buildings in starting or supporting large fires. The relative difficulty in handling fires in them depends not only on the character of the materials and source of the danger but also on the manner in which the materials are stored. Fires in certain kinds of materials can be fought only by tearing the piles physically apart with clamshell diggers, bulldozers, and other material handling equipment. The first rule of fire protection is good housekeeping: separating and protecting the piles of material, and limiting the amounts stored in any one pile. For ordinary combustibles, open space should be in the order of 80 per cent of the total storage area, although few yards at present observe such a limitation. Materials handling equipment and an adequate supply of water on the premises should also be required.

(2) Structures Other Than Buildings

High fire risks exist in structures other than buildings, such as ships, railroad rolling stock, airplanes, gas tanks, other storage tanks, above-ground pipe lines, and bridges. In some cases, the best defense is one of spacing, in some cases blast-resistant construction will help to reduce risks, and in others the same principles in the case of buildings may be applied.

(3) Steel Frame Buildings

Steel frame buildings in which the framing members are unprotected are widely used in industry. Although the structural members do not contribute to a fire, they have little resistance to heat, and are thus unreliable when they have combustible features such as wood roofs or wood interior partitions, or when their contents are highly combustible. Otherwise, they are well-suited to industrial use, and usually are protected by automatic sprinkler systems and by careful supervisory services.

(4) Fire-Resistive Buildings

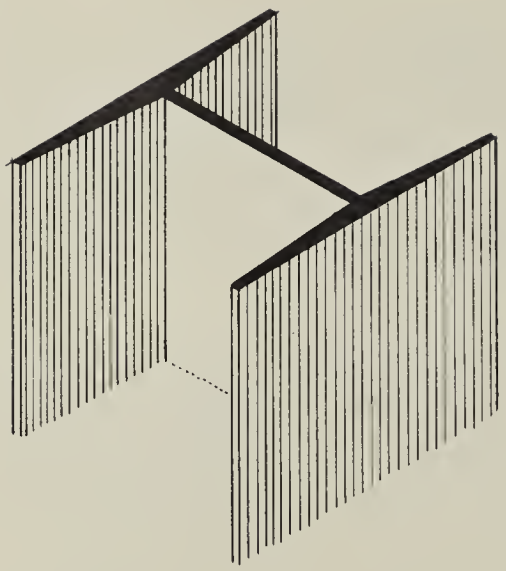
"Fire-resistive" is a relative term. The degree of fire resistance built into a building must be proportional to the fire loading to be

expected. Fire loading is the amount of heat generated by the burning of the contents of a building. The total material in any one room or area is assumed to be uniformly distributed, and the loading is expressed on a square-foot basis in terms of the B.t.u.'s which can be generated by the combustion of the weight of material per square foot. Fire loadings can also be expressed in terms of duration of the fire to be expected, which is also directly related to the amount of material available to burn.

In order to give some understanding of the practical meaning of fire loading, it may be noted that lumber averages 8,000 B.t.u. per pound in calorific value. A further indication of reference points in this subject may be obtained from the determinations of fire loading which are summarized in the table on page 67.

Fire resistance is usually specified in terms of the heaviest occupancy fire loading for which a building might be used in the course of its normal life. The recommendations in the PROJECT EAST RIVER Interim Report may be understood on this basis. In fire-resistive buildings, it is customary to relate the degree of fire resistance to the fire loading of the contents, generally in two grades: three-hour resistant and two-hour resistant, as identified for convenience by the fire resistance of the floor construction (slabs, beams, and joists). For the three-hour grade, columns, girders, and trusses must be four-hour resistant when they support more than one floor or roof; interior partitions enclosing stairways and other openings must have two-hour resistance. A grade of construction giving one-hour resistance is also recognized, in which steel or heavy combustible structures are protected in such a way as to give floors and other components one hour resistance. (Resistance times are determined from standard laboratory tests.) For illustration of fire-resistant construction see figure 22.

The recommendation of horizontal compartmentation for every 1,600,000,000 B.t.u.'s of fire loading means in office buildings (typical fire loading 160,000 B.t.u. per square foot) compartments of 10,000 square feet. For higher loadings, as in department stores (typical fire loading 240,000), compartments would have to be smaller—6,600 square feet. Where fire loadings are low enough to permit the use of an unprotected steel frame building, compartments could be 80,000 square feet, or practically unlimited. In practical administration, the calculation of fire loadings for civil defense purposes might well be reduced by making allowance for temporary compartmentation provided by such containers as steel filing cabinets, closets, etc.



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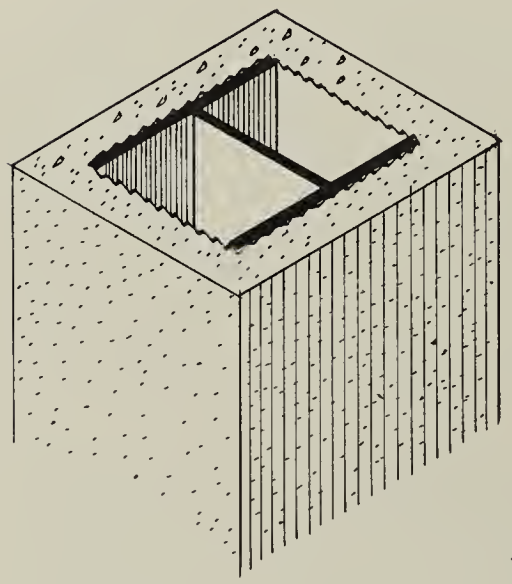
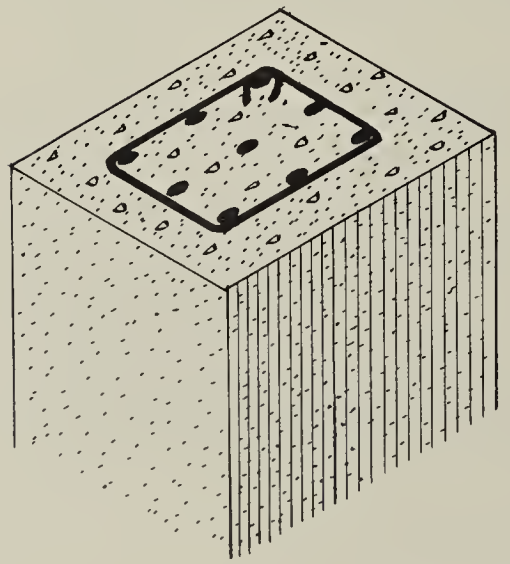


1- HOUR
1-1/2" CLASS II CONC.



FIRE RESISTIVE
4-HOUR RATING
1-1/2" CLASS II CONC.

FIGURE 22
FIRE RESISTANT CONSTRUCTION
Schematic illustration of fire protection for framing members.

FIRE LOADINGS TYPICAL OF THE CONTENTS OF SELECTED BUILDING COMPONENTS

(Source: National Fire Protection Association)*

Duration of Fire	Component	Fire Loading (B.t.u./sq. ft.)
1/4 hour	Hospital wards Assembly halls Steel rolling mills Metal stamping	20,000
1/2 hour	Living rooms Hotel bedrooms School classrooms Bath houses Storage garages	40,000
1 hour	Offices with light files Auto assembly plants Restaurants	80,000
2 hours	Apartments Hotels General offices Churches Schools	160,000
3 hours	Textile knitting and weaving Libraries and museums Department stores	240,000
over 3 hours	Woodworking establishments Heavy record storage Book store (filled) Rubber warehouse	300,000 300,000 2,000,000 2,000,000

* Reference books on fire loading include N.F.P.A. HANDBOOK OF FIRE PROTECTION, National Fire Protection Association, Boston, Tenth Edition, 1948, 1568 pages, $10.50; and FIRE GRADING OF BUILDINGS, British Post-War Building Studies, No. 20, Ministry of Works, Her Majesty's Stationary Office, 1946, 120 pages, one shilling sixpence.

The latest published material giving a consensus of qualified experts on the relationship between test data on various combinations of materials and the requirements of municipal building codes is contained in a report on STANDARD TYPES OF BUILDING CONSTRUCTION by the Building Construction Committee of the Fire Protection Association at its annual meeting in New York, June, 1952.

In many buildings fire protection depends in large measure on automatic sprinklers which, together with the good housekeeping which is a first essential in fire prevention, provide peacetime protection of a high order. Sprinkler systems are particularly common, and effective, in buildings with high occupancy fire loadings. To assure a high degree of this automatic protection against the initiation of small fires under atomic attack, PROJECT EAST RIVER has suggested that automatic sprinkler systems be required for high fire loadings, and that sufficient water supply be stored on the premises to give some confidence that the sprinklers will continue to operate for the critical hour after the attack when the building has not been seriously injured but normal municipal water supplies may be cut off. (See figure 23.)

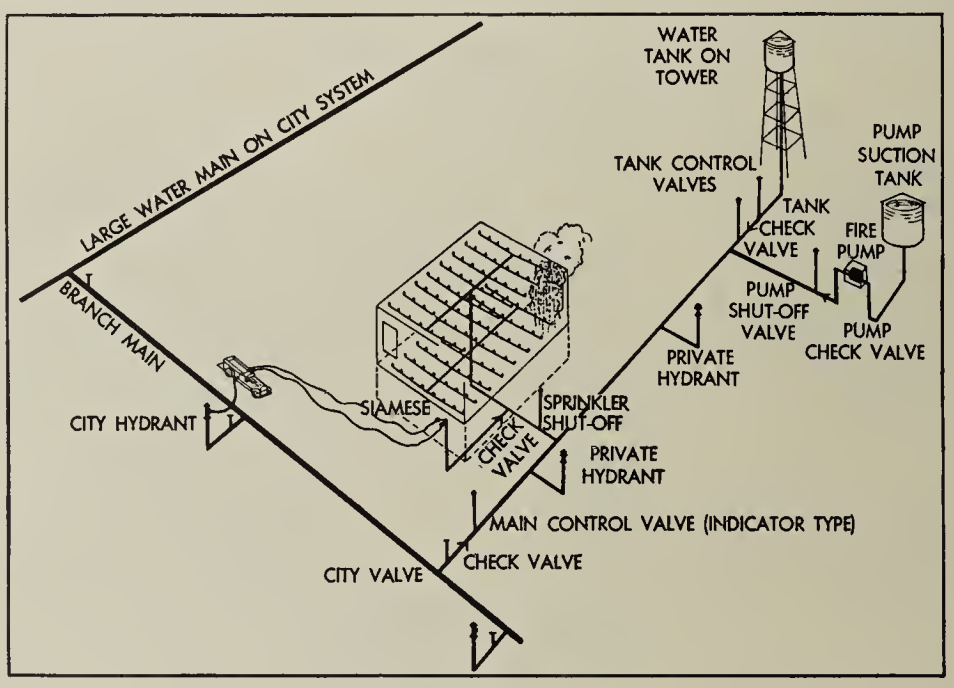


FIGURE 23

ELEMENTS OF STANDARD FIRE PROTECTION

The component elements of fire protection provided by standard U. S. practices. Sprinkler systems are for the most part served by water supplies from public mains, but in the case of many industrial plants there is an additional source of water for fire protection provided from a water tank on a tower, from a fire pump or from both, as illustrated.

In wartime, the city system may be without water due to thousands of breaks at service connections, so water supplies for sprinklers will have to be principally those illustrated, which are at the building protected. For wartime fire protection, the principal additional cost item in connection with sprinkler protection would be to provide water in a pump suction tank arranged as shown. For many industrial plants, which now maintain pump suction tanks, the problem will be a matter of adding tanks or reservoirs to increase the amount of water stored for fire pump suction.

(5) Combustible Buildings

PROJECT EAST RIVER has recommended that, in general, roofs be protected to the highest possible degree against the spreading of fire. The use of wood floors and door trim and small amounts of other combustible trim is not considered to invalidate the concept of fire resistance in construction, but significant amounts of combustible material in partitions and wall or ceiling finishes would affect it. Decorative, acoustical, and insulating finishes should be noncombustible types.

Combustible buildings are a far greater hazard. Differences between the building with brick walls and wood interior construction and the all-wood type, although measurable, are so slight that the two types may be considered together. These buildings contain enough combustible material to make intense fires of long duration regardless of their contents. The vulnerability of the United States to fire destruction is principally due to such buildings. For this reason PROJECT EAST RIVER has recommended that construction of these buildings be banned in Class I Vulnerable Urban Districts. For existing areas of combustible buildings, there is no alternative in the long run to restricting the total percentage of ground area which they cover to the order of 20 per cent, so that too few fires may simultaneously get under way to create the dreaded fire storm. In the meantime combustible buildings should be modified in the various ways recommended for peacetime improvement: enclosing stairways, providing sprinkler protection, giving attention to common and special fire hazards, and supplying throughout the area special pools and cisterns of water for emergency fire fighting purposes.

All of these fire requirements deviate from present practice principally in bringing the amount of combustible materials allowable at any location to near manageable quantities. The prohibition of combustible buildings and combustible areas in noncombustible buildings involves no added expense in the community sense. The reduction of building bulk and area and the prohibition of combustible features such as wallboards may add slightly to building costs. No valid generalization is available for the lowered fire loadings which may increase building costs but lower insurance rates and day-to-day operating costs. The same applies to improved automatic sprinkler systems.

The standards suggested have been expressed for the maximum fire loading that each type of building construction will permit. The sprinkler protection requirement would apply to apartments and residences only if the occupants were unwilling to accept a reasonable reduction in combustible contents and a better level of housekeeping in the future. In large apartment buildings, stores and storage areas sprinklers would have to be supplied. This procedure is recognized as good practice in peacetime.

The most effective fire measure is the requirement of spacing, but that would be prohibitively expensive as applied to existing buildings. For new buildings, however, space can be required, and building layout can be so arranged that the spread of fire from compartment to compartment or building to building is impossible both vertically or horizontally, whether within the structure or across limited open areas. Accordingly, the use of wood in window frames or trim should be prohibited in new buildings.

c. Standards of Protection Against Biological and Chemical Weapons

Protection measures considered in this report are designed primarily against the blast and radiation effects of the A-bomb. For the present, it must be assumed that protection against biological and chemical weapons is far too complex to be provided within the structure itself, and that primary reliance against these weapons will have to be placed upon individual masks. Such masks are currently not available for children under four, for whom other means of protection must be found.

Consideration of biological and chemical warfare agents has led to the study of special filters for air-conditioning units and of simple impregnated beaverboards which transmit air through diffusion and may serve to protect shelter areas in buildings without expensive ventilation machinery and equipment. For the present, these measures cannot be generally relied upon for protection.

Shelter areas will provide a good means of preventing gross contamination of people by chemical or biological agents, if the shelter can be closed off by substantial doors and if other openings to the outside can be avoided. Decontamination following chemical or biological attack would be greatly simplified by these means. Broom closets could be located for future use as chemical toilets.

In the case of major public buildings and command posts, it may become necessary to develop sealed-off areas which prevent all contamination. For the present, the cost of completing such areas is not justified, but the planners of these buildings could, with small additional cost, greatly simplify the future conversion of the area. In planning, provisions should be made for placing doors which can be sealed; locating toilets within the area providing shower heads; arranging for access through toilets within the area; providing shower heads; arranging for access through decontamination areas by those who wish to enter the protected

areas; specifying air conditioning plenums large enough to carry special filters; planning special water and electric circuits for emergency operation with standby equipment; and providing for air circulation within the protected area through louvers or other openings. Obviously, more space per person will be required in an area of this sort than in the normal shelter areas.

Since most chemical warfare agents are heavier than air and tend to accumulate along the ground, shelter areas in the basements and lowest stories of buildings in the highly congested areas which are suited to attack by such weapons may have to be abandoned. It will be necessary to provide warnings to those taking shelter in such locations when chemical attacks occur, so that masks and other countermeasures can be employed. Implicit in this recommendation is the requirement of means of communication with shelter areas in specific locations, by telephone or walkie-talkie, in addition to general radio communications.

d. Protection Standards for Production, Services, and Utilities

Critical plants and processes require protection as well as persons, and in many cases the means of protection involve similar engineering considerations. The general opinion is that industrial organizations should provide protection for their own facilities, subject to some pressure under the various incentives discussed on page 96. The same principles should perhaps apply to key utilities and services. It should be noted that funds have not yet been requested for Federal assistance in structural protection other than for people.

For utilities and services generally, a distinction may be made between basic facilities and the distribution system. The principal civil defense concern is to restore operation as soon as possible; so far, the distribution system protection measures consist mainly of providing auxiliary equipment and materials for emergency repairs. For the facilities, structural protection may frequently be required, sometimes to a standard much higher than that provided generally, because the failure of a critical facility may put out of effective use a wide section of a metropolitan area.

The most economical and effective measures for assuring the continuity of vital war-plant operation may represent a delicate balance between a number of factors: whether to attempt to protect key machinery and equipment, to provide standby means of restoring production after attack, to duplicate the key machinery and equipment as a different sort of insurance against attack, to relocate entirely in a less vulnerable part of the country, or to go underground. The final decision will depend on a variety

of technical, production, and economic factors in addition to the normal engineering considerations of protective construction. For each plant, the answer in any given situation might prove to be unique, but consideration should be given to an investigation of these problems by mathematical probability analysis; this procedure may provide a method of assigning the proper order of importance to the various factors affecting choice.

Critical war plants have been placed under the cognizance of the plant protection programs of the Department of Defense. Although primarily anti-espionage and anti-sabotage in character, these programs include a series of protective construction recommendations and employ survey forms for information on shelter capacity. Coordination of this activity with the protective construction work of the Federal Civil Defense Administration is clearly indicated, and in the opinion of PROJECT EAST RIVER, effective over-all protection would be improved if the military were to leave this field clear to the civilian defense agency. The sewing machine plant of today may be the critical war industry of tomorrow, or the converse; in the long run, the military will be more able to devote its attention to military matters if it not only gives to civil defense but also charges it with the responsibility for developing and carrying out effective protective construction measures for every part of the nonmilitary operations of the country.

e. Priorities in the Application of Standards

Current civil defense policy rejects the establishment of an order of priority among cities listed as target areas, accepts the view that civil defense plans must be made upon the basis of a warning time of no more than five minutes, and assumes attacks of short duration and no constancy as compared with those of the last war. The first of these views is reflected in the Federal Civil Defense Act of 1950. Of these views, PROJECT EAST RIVER accepts only the last, and on that basis agrees that shelters should provide only the barest minimum of accommodations for sanitation and comfort. It appears preferable to force people to spend one or two rather uncomfortable sessions than to double the shelter cost which would be involved if extensive sanitary facilities were to be provided in every shelter area. In modifying certain buildings, it might be desirable to place drains in the area for later use. In future buildings, it would be desirable to plan regular toilets in or near the shelter areas, with occasional shower heads for decontamination activities.

The problem of warning time and the effect of the PROJECT EAST RIVER assumption of one hour's effective warning have already been discussed. In the matter of target priorities, PROJECT EAST RIVER also challenges present policy, and assumes that an order or priority

in the protection of target areas makes a great deal of sense. Some sort of continental location factor is indicated, and after that has been applied, protection should go to the largest and most vulnerable targets first.

In a recent study[33] dealing, on a statistical basis, with a wide variety of assumptions involved in formulating a shelter program, there was a definite indication that the greatest economy in allocation of protective construction funds would result from the provision at the very start of the total optimum standard of protection called for in any one city. These studies would make it appear wasteful to give partial protection to a whole list of cities when funds are short, and economical to provide complete protection for the most essential few cities first; other cities could be taken care of as additional funds become available. Unless the economic advantage is large, political considerations may oppose such procedures, but certainly the issue is an impartant one which calls for reappraisal by the Congress of its present policy.

f. Basic Data and Needed Research on Structural Standards

(1) General

The intelligent planning of a program of defense by structures depends in part for its success on the extent of knowledge of the many effects of possible weapons and the resistance of people and structures to such effects. The following discussion sketches briefly the present state of knowledge concerning the effects, indicates where present knowledge is inadequate, and suggests methods of study.

A vast amount of research has been accomplished on the effects of atomic weapons on animals, people, and structures. Over a score of atomic weapons have been detonated by the United States and in every case various measurements of physical phenomena have been made, some with a great deal of certainty, others with little. The general state of the art of predicting extent and character of damage to people and buildings is fair. The following section under (2) touches on areas of knowledge which are fairly well in hand, while the areas of greater uncertainty are described in section (3).

[33] Lehigh University, Institute of Research, Investigation and Design of Air Raid Shelters, Report No. 8, Volumes 1 and 2, ANALYTICAL METHOD FOR ESTABLISHING A SHELTER PROGRAM, October 1951.

Not all of the information described under section (2) is available to the public. A vast amount of basic information is available in THE EFFECTS OF ATOMIC WEAPONS prepared under the direction of Los Alamos Scientific Laboratory, but much is in a form difficult to apply in practical cases of structures design. The Federal Civil Defense Administration has recognized this deficiency and is preparing a number of manuals which will form a basis for the following activities by engineers and architects:

(1) Selection of Shelter Areas in Existing Buildings
(2) Improvement of Buildings for Shelter Areas
(3) Design of Communal Shelters
(4) Construction of Home Shelters
(5) Guide for the Design of Buildings Exposed to Atomic Blast
(6) Manual for the Design of Shelters

In addition, consideration is being given to ways of issuing information for the design of new structures to resist (to varying degrees) the effects of atomic weapons. The Federal Civil Defense Administration has plans for the contracting of work necessary for such a design manual but no positive action has occurred. The Chief of Engineers, Department of the Army, however, has contracted[34] for the preparation of a design manual for military structures. Much of the information in this manual will probably be useful for civil structures. An interim design manual is currently being prepared[35] for the Chief of Engineers, Department of the Army. The first draft of this manual will be available in the summer of 1952. Both of these manuals will probably be classified, which will restrict circulation until security is down graded.

(2) Information Subject to Analysis

Until the accomplishment of Operation Greenhouse in the spring of 1951, the most used data relative to the effects of atomic weapons on structures were those available from the Hiroshima and Nagasaki incidents. In the experimental detonations of atomic weapons conducted before and after the incidents in Japan, only minor tests have been made of structures until Operation Greenhouse, except for the naval ships exposed in the Bikini tests. The experimental evidence available on a number of effects and resultant responses is in sufficient agreement with rational theory to suggest that the information may be applied with reasonable con-

[34] Under Contract DA-49-129-eng-178.

[35] Under Contract W49-129-eng-148.

fidence. The following sections outline the information which falls within this category.

(a) Radiation Effects

The intensity of radiation effects, both thermal and nuclear, as a function of distance and size of weapon is well-defined.

(b) Blast Effects

The pressure versus time relationships of the air blast wave from an atomic detonation can be fairly adequately described.

(c) Blast Loading Imposed on Structures

The knowledge of pressure versus time and pressure versus distance relationships near the ground surface for various size bombs and conditions of detonation is not sufficient in itself to permit the establishment of the force time curves of applied load to the various surfaces of a structure in the path of a blast wave. The diffraction of blast waves around structures of even simple shape is a relatively complex sequence of events. Knowledge of this sequence is necessary to permit analysis or design of structures built to withstand or partially fail under the influence of the blast pressures.

These facts have been evident to many people engaged in research on atomic weapons. The Los Alamos Laboratory group have not been charged with this problem but rather with the problems described above. The main burden of the solution of this problem has rested on other shoulders. Lack of progress is not due to lack of ability of those working on this problem but rather to the fact that in the field tests of atomic weapons much less emphasis has been given to the actual loading problem than to the other problems relating to basic weapon efficiency.

Nevertheless, considerable progress has been made on the loading problem due to the structures program at Operation Greenhouse; the extensive shock-tube studies carried on at Princeton University, Ballistics Research Laboratory, Aberdeen Proving Ground, the University of Michigan; and to the theoretical and small-scale field-test studies carried on at several locations.

It is now possible to predict the diffraction of blast around geometrically simple structures with the use of the results of the Greenhouse tests correlated with the data from shock-tube studies. The

exact force-time description for complicated re-entrant shapes may be beyond the possibility of practical solution except by model studies.

The information upon which the force-time relationships can be predicted for any initial side-on blast pressure intensity is not now readily available to designers—even those operating within the military security realm. Efforts are being made by Armour Research Foundation under contract to the Air Forces and Massachusetts Institute of Technology under contract to the Army Engineers to establish and publish simple yet reasonably accurate procedures for the prediction of force-time curves of loads which would be imposed on the various surfaces of practical shaped structures.

(d) Analysis of Dynamic Structural Response

The application of exact and approximate dynamic analysis procedures for simple to relatively complex structures with either all-elastic or elastic-plastic response is now possible and practicable. Approximations are necessary to permit the handling of complex structures.

The theoretical analyses of the various Greenhouse structures agreed fairly well with the transient and permanent damage results. Theoretical analyses of relatively complicated structures have been carried out. It is doubtful, however, that the dynamic analysis procedure methods are so described that any but a few of the many consulting engineering firms can apply these procedures to analysis problems. Other engineers doubt that this is possible.

(e) Design of Structures

The procedures used in the design of structures to resist the effects of atomic weapons are based on the dynamic analyses discussed above.

The design of structures to resist the effects of atomic weapons with partial or no failure is an art which has been practices by but four organizations in the United States and perhaps the world. The design procedures used are based on the dynamic analysis procedures described above.

As a result of the Greenhouse studies, and particularly the efforts of the Chief of Engineers, Department of the Army, through its research contracts, design manuals for atomic-resistant construction are being developed which probably can be applied by the majority of competent engineering firms in the country. At the present time, however,

it is contemplated that these design manuals will have circulation limited to those groups permitted to have and use security classified information. Efforts will have to be made to overcome this difficulty without compromising the security of the nation.

(f) Nuclear Shielding

The effects of nuclear radiation on animals have been studied extensively. Using information gathered in these studies together with the casualty reports from Hiroshima and Nagasaki the casualty rates for human beings for various amounts of total radiation dosage have been estimated.

The total dosage of initial gamma radiation from any size bomb may be predicted; information for this purpose is included in THE EFFECTS OF ATOMIC WEAPONS. The shielding or attenuation effect of material on nuclear radiation can also be predicted from data in this book.

(g) Detail Considerations

There are many details of construction which will improve the performance of structures in resisting the various effects of atomic weapons. These details are those which, while not commonly employed in construction practice since there has been no need for them, are in most cases relatively simple of application and in some cases inexpensive.

As more experience is gained in the design of structures to resist blast effects, more useful and less expensive details of construction will be evolved. These details will come from the practicing engineers, architects, and contractors. As standard procedures are developed, they should be modified as suggested later. Several attempts have been made to publish general information on this subject[36]; more must be made.

(3) Information Required

The information on a number of subjects necessary for intelligent planning of defense by structures is either lacking or in an early stage of collection or development.

(a) Casualties to Personnel

The extent and character of personnel injuries due to the various effects of atomic weapons are extremely difficult to estimate.

[36] See THE EFFECTS OF ATOMIC WEAPONS, DAMAGE FROM ATOMIC EXPLOSION, and DESIGN OF PROTECTIVE STRUCTURES, U. S. Government Printing Office, and the FCDA publication GUIDE FOR THE DESIGN OF BUILDINGS EXPOSED TO ATOMIC BLAST.

This is true because the variables are many, chance plays such a large role, and injuries due to secondary missiles are not very susceptible to prediction.

This problem is certainly very complex and one that may only be solved by actual trial. It is possible, however, to construct buildings such that casualties will be eliminated or minimized to a fairly well definable degree. It may always be impracticable to make anything more than gross estimates of expected casualties suffered by people sheltered in conventional buildings subject to the hazards of flying glass, falling fixtures and ceilings, and projected missiles of various origins.

(b) Structural Parameters

The service groups participating in the structures program at Operation Greenhouse had good success, with some exceptions, in predicting the damage that their structures would suffer, and would presumably be able to predict damage to similar or other structures under different conditions of blast loading. There are, nevertheless, some gaps in our knowledge of structural parameters required by analysis or design procedures. Following are the most obvious classes of information needed for analyses of existing structures.

Resistance of typical interior partitions in shear and flexure.

Resistance of common methods of connection of non-bearing partitions.

Resistance functions for the following types of reinforced concrete framing: flat slabs, pan joists, and beam and slab.

Resistance functions for various types of riveted joints and connections, including buckling problems.

Resistance functions for masonry elements in flexure and shear.

Dynamic strength of construction materials.

Laboratory research projects are underway on several of the above subjects, and a field test with an atomic weapon is being planned by Federal Civil Defense Administration on some of the subjects.

It is important to note that indiscriminate full-scale tests of various types of buildings are probably unwarranted and foolish. While more atomic tests on structures are needed for an adequate know-

ledge, it is undoubtedly true that many of the required tests in the field will be tests of elements of structures which may not resemble practical structures to the uninitiated engineer's eye. Efforts must be made to avoid the squandering of public funds on costly structures which will yield limited information. Instead, the field structures tests should be carefully coordinated with laboratory research such as has been carried out at numerous university and government laboratories. Full-scale tests may be required in cases for check purposes. Such tests must be very carefully planned.

From a different point of view, vulnerability studies of standard building types would be very useful in the definition of assumptions for the preparation of policy, for example on such questions as dispersal versus protection in place.

(c) Fire Effects

The effects of fire initiated by the primary and secondary effects of atomic weapons are extremely serious. The evidence at Hiroshima and Nagasaki amply demonstrate this. The initiation of fires by secondary effects and the uncertainty of a fire continuing and spreading introduce complexities into the fire problem which are extremely difficult to assess.

A vast amount of information has been gathered on fire continuance and fire spread from the many civil fires which have occurred over the ages. The technology of causing fire damage by incendiary bombing was studied extensively during World War II. The conditions necessary for the all-dangerous fire storm are less well-defined.

The state of the art of predicting extent and character of fire damage is poor in comparison to that of predicting blast damage to structures. Yet fire may be expected to play a major role in any atomic attack on a combustible or partially combustible target. For this reason it is evident that further fundamental studies should be undertaken of fire initiation, support and spread, fire-storm technology, and the effectiveness of various measures (including emergency water supplies in buildings and cities) in stopping or limiting fires. The contributions of the fire insurance companies and the National Fire Protection Association have been many in this field and should be used in any continuing program.

(d) Window Problems

The whole window problem needs detailed attention. Protection against glass, against blast, against fire initiation and spread, and against chemical and biological weapons must be considered together as parts of a whole. Even in the parts, there has been little research. So far

no group has given anything but rather limited study to the problems involved and the possible solutions.

(e) Underwater Bursts

A number of cities including Boston and New York have been concerned with the hazards which would result from an underwater burst in the harbor. The information available on this subject is scanty. However, it must be pointed out that the solution of the problem of the vulnerability to an underwater burst is very complex and would be extremely costly to carry out.

The Federal Civil Defense Administration should take positive action on this problem by initiating a program of research which will take advantage of the work already underway and will be directed at giving reasonably approximate solutions to the hazards of radiation, wave action, and flooding caused by an underwater burst.

(f) Underground Construction

Information is also needed on the protection to be afforded by going underground. This method was used frequently during the last war and is currently used in several European countries. In Sweden, according to the Federal Civil Defense Administration, the cost of constructing industrial plants underground has been only 15 to 20 per cent higher than normal construction, and there have been some compensations in the form of reduced heating and other operating costs.

Studies on this subject have been going on in this country for some years under the direction of the Chief of Engineers, Department of the Army. Actual surveys and cost estimates have been made for specific industrial operations. Most of the information thus gathered remains classified, but it has been publicly revealed[37] that this country has available several hundred million square feet of underground space, and that in many locations, available underground areas have doubled since the making of the surveys. Most of the best sites were located in the general area of the country in which the major part of industrial production is now located. Limestone mines proved the best locations, but sandstone, copper, lead, zinc, and even salt had possibilities, although the last were usually very deep. Temperature and humidity in these areas were relatively constant, and the areas were easy to use either as cold storage or as heated spaces, in which the heat generated by operations was often enough to heat the space. The principal problem was air supply.

[37] By Martin D. Kirkpatrick at the Conference on Building in the Atomic Age held at Massachusetts Institute of Technology, June 16 and 17, 1952.

The actual operations studied in detail included a precision manufacturing plant, a chemical processing plant, and a storage depot. For the last, underground location proved very efficient, with construction costs only four-fifths of what they would have been over ground, and with operating costs also reduced through a number of design efficiencies. For the other operations, the cost differentials may be seen from the following table, in which costs are given as a percentage of the cost for a comparable existing above ground plant.

Underground Location	Construction Cost	Operating Cost
Existing Mine	120-135%	102-104%
New Excavation	145-160%	103-106%

These figures do not appear to offer immediate hope of complete security at little cost, but they certainly bear investigation as part of the general study of protective construction. A special committee was convened at one time by National Security Resources Board to consider this problem, but its report has never been adopted or released. For the key facilities which must be secure and which cannot be sufficiently protected by dispersion, at least, this subject bears further study.

(g) Utilities and Services

Data are needed on the means of protection for utilities and services as well as more usual structures. Some aspects of these problems will be tested in the extensive program of testing walls and partitions which is currently underway. And some of the tests in the past have given indications of the performance of buried and exposed pipes, etc. The test programs in this field in the past have never been run off, presumably because they required substantial funds which were not available, but partly also because they were not part of a comprehensive program of tests on the whole protection front. The Federal Civil Defense Administration has itself recognized this limitation and intends to create a Research and Development Division to coordinate the program, secure the necessary approvals, and proceed with the whole range of essential research.

g. Making the Standards Available to Designers

Although it is desirable for states and communities to have complete freedom to plan their own protection, the importance of conserving manpower and materials and the need for Federal financial assistance tend to bring about central standards and controls for all shelter construction. Although standards will vary with communities, depending upon geographic location, probability of being attacked, etc., central supervision of standards is probably desirable.

Many of the standards currently used by Federal Civil Defense Administration, and proposed by PROJECT EAST RIVER, have already been discussed. Further standards will be derived from the data accumulated in the test programs which have been recommended. These standards should be so presented as to make it possible for the designer to get a reasonably precise idea of what will be gained from the measures suggested, and what these measures will cost—but this will not be easy.

This broad design problem may best be approached by borrowing freely from a summary discussion by Merit P. White at the Conference on Building in the Atomic Age held at the Massachusetts Institute of Technology on June 16 and 17, 1952. White suggests that the problem of designing structures to resist blast be divided into four parts. First, a scientific determination must be made of the forces exerted upon structures by the atomic bomb, and here there remains a high degree of uncertainty despite frequent and careful tests. Even for the simplest structure there is no certainty of the force-time relationships from a known blast loading. At the opposite extreme, the often recommended structure with walls which are breakable or have breakable panels makes the calculation of loads almost hopeless. To these uncertainties must be added the fact that the design must resist the effect of a weapon whose size and position of detonation are unknown. It may be concluded that assumptions regarding forces must be simple and general.

The second problem is that of developing methods of analyzing structures. There has been some doubt that methods of analysis were sufficiently simple for normal use, but current efforts toward simplicity are encouraging.

The third problem, and the most difficult, is that of developing methods of designing structures. Before real progress can be made, some agreement must be reached by designers on their general aims, on the order of accuracy that they seek, and on the relative importance of blast-resistant versus ordinary design. Obtaining this agreement is the fourth problem. Materials and methods which may carry great novelty appeal will not survive unless they can pay their way in normal terms.

Practical systems are required which are capable of being used by an ordinary designer without taking any special courses; they must be quick; they must be no more accurate than the original data; and they must be physically understandable to the designer. It is futile to give a designer a set of curves or a table and tell him to go ahead; he must be able to visualize the forces that he is applying and develop a physical feeling for their action, as has been the case in earthquake design.

As a result of observations in Japan, a method similar to that for earthquake design has been proposed for securing blast resistance. The method consists in assuming, as acting on a structure, hypothetical forces of constant intensity and proportioning the frame to resist these forces, with the lateral static pressure assumed somewhat larger as the resisting element is lighter, and with the static design pressure varying over a considerable range of values determined theoretically by more complex methods of analysis. If it can be developed, such a method offers the convenience of working in terms of static strengths, and it avoids the danger inherent in more refined methods that the careless user will be deluded by the precision of his method into forgetting the crudities inherent in the assumptions with which he must work.

Mention has been made of some of the subjects in the urban protection field on which Federal Civil Defense Administration has been preparing manuals. These manuals are designed for different purposes and often for specialized audiences. Nevertheless, they should in every case carry an introductory statement describing the broad nature of the protection problem and giving general warning to the reader on the dangers of fire and the possibilities of defense by space. Manuals on protective construction which do not indicate these important related problems may lead to serious errors of judgment.

It is understood by the Federal Civil Defense Administration, and this must be made clear to the public, that most manuals are necessarily interim. Information should be released as fast as it is available, but, by the same token, revisions should be issued as knowledge is improved. This attitude should make it possible, among other things, to clear manuals more quickly than has recently been the case in the Federal Civil Defense Administration. For example, the INTERIM GUIDE was originally expected to come out in about three weeks in the summer of 1951; it was reviewed in detail, however, not only by the Administration, but also by several other Federal agencies and by five national associations; it is now scheduled for publication on July 6, 1952. The SURVEY MANUAL, much simpler in its basic character, took less time: from March to August 1951. One of the greatest achievements of the proposed Research and Development Division in Engineering Services would be to find a simple and speedy way to review work against a coordinated background of policy and standards. So organized, the new division could also be of great use to those outside the agency who might like to have the benefit of a review or even approval by the experts in the field.

By and large, it is probably desirable to have the Federal Civil Defense Administration limit its publication activities to supplying basic information and data, leaving it to others to suggest specific designs

and applications. On home shelters, however, specific guidance by a qualified agency is in order. Although a manual on home shelters is in process of preparation, the general problem requires further attention, including the comparative analysis of basement shelters, slit trenches, or no shelter at all in residence areas, and the complexities that accompany any such decision. The suggestion of specific design types for certain industries is useful, and a manual on windowless structures has been released.[38] Even standard shelter designs are useful in the early stages of experience in this field. As experience grows, however, the initiative in design will belong where it lies in other areas—in the inventive capacity of private designers.

Indications of the importance of nonofficial publication in this field are readily available. Both the American Institute of Architects and the American Society of Civil Engineers have active committees and have prepared an extensive professional literature on structural protection. Several states, municipalities, and private firms have published their own suggestions for design.

4. DETERMINATION OF SHELTER NEEDS

a. Past and Present Efforts

(1) Bureau of the Census Sampling Survey

It was suggested in the Technical Conference of the Federal Civil Defense Administration in April 1951, that a sampling survey be undertaken to determine, as accurately as possible, the extent of the shelter problem. This was proposed as a working and budget tool only, and the results were not to be published. The suggestion was discussed with the Bureau of the Census, which found that it would involve selecting 100 to 150 blocks in 15 metropolitan areas for detailed study and would cost approximately $200,000. The Bureau of the Census made it clear that its official endorsement of the survey would be conditioned on its hiring personnel and maintaining control throughout. The money for the survey was never appropriated.

(2) Federal Civil Defense Administration Survey

The first need in determining the scope of the problem of structural protection is the accurate determination of existing shelter supply and current shelter need. In large part, the refusal of Congress to appropriate money for the provision of shelter areas undoubtedly stems

[38] Windowless Structures—A Study in Blast Resistant Design, FCDA Document No. TM-5-4, June 1952.

from its suspicion that the Federal Civil Defense Administration could not back up its policies and its budget requests with reliable, detailed facts. Refused money both for shelter construction and for a sampling survey to determine the order of magnitude of needs, the Federal Civil Defense Administration turned to the device of a voluntary local survey for the information it needed in order to fill in the numbers in a graph like that in figure 15 (page 50). The Technical Conference has already expressed the hope that local professionals might contribute their services in locating shelters, and that Federal funds would be made available for preliminary engineering studies to bring suitable areas up to standard. Furthermore, Federal matching funds were contemplated in the basic civil defense act, even though Congress had not as yet appropriated funds for this purpose. Armed with these hopes and inducements, the Federal Civil Defense Administration set out to persuade the cities to make the surveys themselves.

A detailed procedure was worked out jointly with the Census Bureau and Lehigh University. Criticisms were made by a panel representing a wide range of Federal agencies and building industry groups. The results were published and distributed in the form of a pamphlet entitled SHELTER FROM ATOMIC ATTACK IN EXISTING BUILDINGS, Part I—METHOD FOR DETERMINING SHELTER NEEDS AND SHELTER AREAS (U. S. Government Printing Office, February 1952). Federal Civil Defense Administration men have covered the country to explain this survey method and persuade state and local groups to carry it out. Undoubtedly, the first use to be made of the survey results will be to present to Congress and the public a quantitative view of the tremendous size of the shelter problem and thus to justify appropriations for preliminary engineering and for constructions. The survey would also make it possible to locate specific acceptable shelters and set their capacities, and to locate those structures which can be made into acceptable shelters with minor alterations. Carried out in substantial uniformity throughout the country, the survey would provide the basis for valuable analytical work on many aspects of the shelter problem.

This survey procedure has been locally criticized on the grounds that it is unnecessarily complicated and therefore expensive, and that the local effort to make professional studies of individual buildings other than first-class buildings, to check on population in the buildings and adjacent streets, and to complete clerical work and tabulations is not justified. Local men have argued that their task is simply to mark the best shelter available, even though in many cases it will have to be very poor shelter by technical standards. Those who have investigated the survey procedures have found that, although simplifications could have been made, they are nevertheless basically sound and useful. A great deal of local work is involved, however, and the Federal Civil Defense Administration men have not found it easy to promote the survey.

At the present time cities are being encouraged to start with C-1 central commercial areas, marked out by the Census Bureau with the help of local planning agencies. Industrial areas and institutional areas were also marked out for later survey, but these have not been released. The Federal Civil Defense Administration now regards these areas as of much less significance, since they tend to fall in spots scattered throughout the metropolitan area. The estimated total number of blocks to be surveyed in the C-1 areas is 100,000, and this is the number of forms printed for local distribution. Although these areas are regarded by Federal Civil Defense Administration as starting points only, the cities are urged eventually to survey entire target areas.[39]

At the present time, 35 cities have undertaken to conduct surveys, and six have completed the C-1 areas. Hartford, Connecticut has been the only city to complete the survey of an entire target area. It may be possible in the near future to correlate a significant number of initial results and to arrive at important first steps toward the formation of policies. The Federal Civil Defense Administration feels strongly that this situation is now well in hand.

PROJECT EAST RIVER would add only that the survey is the absolutely essential first step, and if substantial further delays occur, a new request to Congress should be made for the necessary funds to permit the Federal Government to take over the task, engage skilled men, and push ahead with good speed and organization to obtain uniform results. At present, however, the Federal Civil Defense Administration has not even requested funds for this purpose. The $6,500,000 requested last year and again this year for "engineering surveys" is for the next step, the specific engineering studies of various structures to devise the manner in which alterations should be made to improve structural protection.

At present, no correlation is sought in the approved survey procedure between the number of people in an individual building and the amount of shelter provided—only block surplus or deficiency is computed. Furthermore, all residential buildings other than large apartment houses or flats of four or more stories and all buildings of less than three stories plus basement are eliminated by the survey. And finally, the survey appears to recommend that only good shelter in first class buildings ("category 1" shelter) be marked for immediate use,[40] though admittedly

[39] This is reported to be the only case of forms being printed by Federal Civil Defense Administration for local use in any phase of civil defense.

[40] The Federal Civil Defense Administration staff, however, does not recommend against using categories 2 and 3, which may be found in wall-bearing buildings.

there are few such buildings in most cities in this country. On all counts, some degree of local action in addition to the survey is already required.

The question may arise of the effect on the Federal Civil Defense Administration's basically block-survey system if longer warning time is assumed. Lehigh University studies indicate that increased warning time would help the shelter program greatly, and probably it would have little effect on the survey system. It has already been indicated above that PROJECT EAST RIVER believes that for future planning purposes, shelters should in any case be provided as close at hand as is possible. The added warning time would make it more easily possible to take advantage of public buildings and major structures such as subways, and so to reduce the complications of providing Federal funds for the strengthening of existing private buildings.

(3) Local Studies in New York and Boston

New York City has requested from the state legislature $250,000 for a combination survey-engineering study, primarily in the high-density residential areas. In the survey, first-class buildings would be located, probably from Sanborn maps, and the amount of available shelter would be estimated with or without a field check (present rule of thumb: 50 per cent of basement floor area at five square feet per person). Areas would then be selected for those who could not be sheltered in their build ings, assuming a 15-minute warning period for movement to shelter. Next, consideration would be given to such special construction measures as the reinforcing of basements in every third tenement. In New York City, major attention is devoted to the problem of the residential areas, while the first concern of the Federal Defense Administration has been for the central commercial areas. This shift of emphasis is probably justified by the special character of the city.

Another example, quite different in character, of the importance of detailed local surveys of demand and supply may be found in Boston where of approximately 400,000 people normally in the downtown area in daytime, nearly 380,000 were found to be within one-quarter mile of some one of the entrances to the subway system, within which, if tube areas as well as platforms were used, nearly 320,000 could find shelter at four square feet per person. Obviously entrance problems would have to be solved. These facts may prove overwhelmingly more significant in planning a program of structural protection in Boston than the detailed study of Boston's buildings, few of which provide suitable shelter areas.

(4) New York Selected Area Study[41]

Data on shelter needs have recently been obtained from a special study in New York City undertaken jointly by PROJECT EAST RIVER and local and national civil defense personnel. In the area studied, some 5,000 people were located in sound frame buildings, 10,000 in "new law" tenements, and 20,000 in "old law" tenements. The "new law" tenements have concrete slab ground floors which can be reinforced to protect 30 people per cellar bay at a total cost of only $80 to $100, if some calculated risks regarding nearby utilities can be tolerated. The number of reinforced bays required depends on the total number of people in the building requiring protection. In the "old law" tenements, an added exit is required, which brings the cost of protecting 35 people in a typical cellar bay to about $900. In areas as densely built up as that studied, insufficient land is available for the construction of communal shelters of even slit trenches. The study raises many legal and administrative problems (which will be discussed later) and the overriding problem of fire danger. People taking shelter in such an area would have to be warned to come out and fight fires after an attack. If many small fires were under way, little chance would remain for escape, because those who were not burned to death would be asphyxiated.

One of the significant aspects of this study may be the information it supplies on shelter costs in a specific case. If, as seems indicated in this New York district, adequate shelter can be provided for as little as $5 per person, or roughly $1 per square foot of shelter space, then it will be necessary to reconsider the shelter cost estimates previously submitted by the Federal Civil Defense Administration. Public financial assistance for providing structural protection may not be required. A building owner may simply be ordered to provide shelter as a public safety responsibility.

b. Shelter Survey Recommendations

From the above it is clear that a survey which concentrates on determining by standardized survey and analysis methods the extent and character of shelter available in existing buildings may not tell the whole story. Local ingenuity can often take advantage of special construction features or facilities in a way which no standard survey could disclose; the consequent savings in cost of protection can be considerable.

While it is recommended that the current Federal Civil Defense Administration survey be carried through at once, if necessary with

[41] See Appendix V-A.

the assistance of Federal funds, the survey should be conducted in such a way as to take full advantage of the special characteristics of each individual city. It is further recommended that the survey should cover as a first step the Class I and Class II Vulnerable Urban Districts. Surveys of additional areas may be undertaken on local initiative, but on a volunteer basis or with local financing rather than with Federal funds.

PROJECT EAST RIVER considers the financing of a program of advance location and designation of adequate shelter areas in the Vulnerable Urban Districts fully as important as the provision of funds for the stockpiling of medical supplies, for which the Federal Government has already spent more than ten million dollars.

5. CARRYING OUT A SHELTER PROGRAM

a. Federal Background in Structural Protection

General reviews of the responsibilities of the government in relation to the problem of civil defense were initiated before the end of the last war by a commission headed by Lt. Gen. W. C. Bull. In the so-called "Hopley Report," CIVIL DEFENSE FOR NATIONAL SECURITY, issued by the Department of Defense, there were included general remarks about the kinds of buildings and construction which afford protection; further study was recommended. Next, the problem was taken over by the National Security Resources Board, which in 1950 issued UNITED STATES CIVIL DEFENSE, an organization plan recommending the creation of the Federal Civil Defense Administration. Manuals entitled DAMAGE FROM ATOMIC EXPLOSION AND DESIGN OF PROTECTIVE STRUCTURES and FIRE EFFECTS OF BOMBING ATTACKS, were prepared by the Department of Defense. Also issued at this time was the publication of the Munitions Board entitled PRINCIPLES OF PLANT PROTECTION. In 1951, Project Charles, in its appendix Volume III, published findings on the economic effects of passive defense and the fire effects of bombing. During all this period, research on the effects of atomic weapons and on the design of structures to resist these effects had been carried on by the Atomic Energy Commission, the Chief of Engineers, Department of the Army, several other Federal agencies, and a number of contractors located in universities and industry.

In 1950 the basic Federal Civil Defense Act was passed (Public Law 920, 81st Congress), calling for "the construction or preparation of shelters, shelter areas, and control centers; and, when appropriate, the nonmilitary evacuation of civilian population" and empowering the conduct of research in protective construction. This act provided that Federal financial contributions for shelter construction were to be on a 50-50 matching basis with the states; allocations were to be in proportion to the

population of each state in critical areas. Contributions by the Federal Government for dual purpose structures were permitted only for elements directly attributable to the needs of civil defense and not capable of self-liquidation. The Reconstruction Finance Corporation was authorized to make 50-year loans for financing civil defense projects, in a total amount of $250,000,000.

Estimates of casualties and shelter costs were worked out shortly thereafter by the Federal Civil Defense Administration with the assistance of Lehigh University, which had undertaken extensive research work in protective construction under contract to the Chief of Engineers, Department of the Army. Total cost of this shelter program ran to $1,730,000,000, of which half would be provided in state matching funds under the law. Since the program was estimated to require two construction years, the Federal share of the annual bill amounted to $432,500,000. This figure represented the major part of the $535,000,000 requested of Congress by the Federal Civil Defense Administration in 1951. No money was granted by Congress for this purpose.

The basis of the early figures has no importance today, but they give an idea of the scope of the problem of protective construction. The total amount asked of Congress for protective construction was almost the same this year as it was last year, for 67 target cities and 22,000,000 people.

Funds were provided by Congress for contributions to the states to aid in the purchase of medical and surgical supplies, training and education equipment, attack-warning equipment, communications equipment, rescue equipment, and fire-fighting equipment. Funds for Federal stockpiling of emergency supplies and equipment in the medical and engineering services were also authorized. For the general safeguarding of vital facilities by engineering measures, Federal Civil Defense Administration in 1951 asked for $35,000,000 of an originally programmed $93,000,000; only $6,000,000 was provided. A detailed program worked out with industry for facilities protection was severely cut by the Bureau of the Budget before submission to Congress. These problems are handled largely in Engineering Services Division, to which only recently the former Shelter Division has been assigned to make possible a coordinated attack on all engineering problems of structural protection.

On general matters of technical policy, the Federal Civil Defense Administration has been very greatly influenced by its April 1951 TECHNICAL CONFERENCE of a group of professionals and key advisors. The

report of this Conference states as a prime objective of civil defense that there should be:

"—prompt designation
—of best available shelter
—in existing structures
—in critical areas
—for every person
—at earliest possible time
—after warning."

The Conference recommended a list of manuals, suggested several standards, indicated the hope that shelter area designation would be accomplished without charge by trained professionals, concurred in the proposal of a confidential sampling survey to find the order of magnitude of the shelter program, proposed that the cost of good professional services be assumed by the government in connection with the modification of buildings to provide shelter, and finally called for the coordination and careful integration into overall shelter plans of the protective construction activities undertaken by private persons.

Current Federal shelter policies which have been stated with some degree of official clarity stem in large measure from these recommendations and seem to be little tied to determinations made on the basis of technical data. They include the following directives:

(1) Concentrate on existing structures.

(2) Extend Federal financial assistance only for shelters which will be open to the public.

(3) Make no structural provision against chemical or biological weapons.

(4) Provide for short-time occupancy only.

(5) Provide austerity standards of sanitation, etc., with maximum use of existing facilities.

Other policies have not been clearly formulated in the absence of specific situations calling for decision.

b. Local Background in Structural Protection

Municipal civil defense agencies in the largest cities have concentrated on designating shelter areas; funds have not been available

to do more. Several state organizations, however, of which California, New York, and Massachusetts may serve as examples, have gone further into problems of structural protection and in some cases have brought out simple manuals which summarize the general characteristics of atomic explosions, the broad outlines of protective construction measures, and some suggestions on steps to be taken. As mentioned previously, New York City has requested funds from the state legislature for a combination survey and engineering study of shelter needs.

c. Costs and Financing

The basic approach of the Federal Civil Defense Administration to structural protection involves four steps. First comes research into the technical effects and means of dealing with them. This is clearly a Federal responsibility, which has been carried out by the Department of Defense, the Atomic Energy Committee, and other Federal agencies and their contractors. According to information supplied to PROJECT EAST RIVER by the Federal Civil Defense Administration, $153,000 out of $183,000 expended on research contracts went for contracts specifically in the structural protection area. Of the estimates for 1952, the protective construction research contracts were $45,000 out of $355,000. Of the estimates for 1953, the research expenditures amount to $3,118,000 out of $4,063,000.

The second step for structural protection is the determination of the facts and possibilities regarding shelter demand and supply. Under current Federal Civil Defense Administration planning, the Federal Government supplies forms and guidance, but the responsibility is given to localities to carry out the survey, using as inducements the possible availability of funds to help in detailed engineering studies of structural measures and eventually to build the structures. PROJECT EAST RIVER believes that sound technical surveys are of the first importance and that little comprehensive or intelligent protection planning can be done without them. If results continue to be slow in coming from the local groups, the Federal Government will have to have the funds and plans ready to move in and obtain the necessary information.

The third step is the preparation of detailed engineering studies for the improvement of structures and the location of new ones so that protection may be provided in the most efficient way in the areas most in need of it. This does not mean the preparation of working drawings, but rather of preliminary drawings which will make clear for the target city the extent of its protection problem in terms of money, materials, and manpower. The Federal Civil Defense Administration has estimated that $13,000,000, or less than one per cent of estimated construction costs, will be

required for this purpose, and has accordingly requested $6,500,000 for Federal matching funds both last year and this year. No such funds have been granted. Many qualified engineers feel strongly that the quality, economy, and timing of the work done under such a program would vary widely over the country, that many of the cities most in need of good engineering services would be unable to provide 50 per cent of their cost, and that in the end services provided under this formula would prove unduly expensive. They believe that an elastic formula is required, so that the Federal Government could advance all the money, if necessary, in order to obtain competent professional advice and to push ahead with good speed. Under such a program, effective use could be made of the best local architects and engineers, and the outlays might be substantially reduced. It is even claimed that a spotting of the major cities could be covered for as little as $3,000,000 or $4,000,000.

The fourth step, and by far the hardest, is the financing and construction of the actual shelter improvements called for as a result of the above. Currently, there is no appropriation for matching funds for this purpose, although the Reconstruction Finance Corporation has been authorized to lend $250,000,000 for shelters which have been certified by the Federal Civil Defense Administration to be necessary (this would be interpreted to mean highly desirable). The chances of extensive use of these funds are small, because under the dual purpose clause in the basic statute, all but the actual protective construction must stand on its own feet for financing. If a building can qualify for support, it can probably qualify for cheaper local bank money. So far, there have been only three applicants, all hospitals, and one of these was able to arrange other financing. It is generally believed that Reconstruction Finance Corporation funds will not be called for until matching funds become available, at which time local sponsors will be able to borrow the local share to match the Federal share. Even then, private financing may prove more attractive in many cases.

The subject of matching funds requires a great deal more study. The major part of shelter construction should be financed by private developers under a wide range of inducements and controls. If costs of protection to adequate standards are as low as $1 per square foot, as was indicated in the Selected Area Study in New York City carried on by PROJECT EAST RIVER,[42] then broad consideration should be given to flat controls in the interests of public safety, combined with compensations in the form of deductions, etc. Costs per occupant may prove considerably higher than $1 per square foot, however. In the early estimates worked out by Federal Civil Defense Administration and Lehigh University, it was assumed that minor repairs would cost on the average $10 per person, major repairs

[42] See Appendix V-A.

$40, and new construction $90. Estimates of the cost of adapting four British-type shelters to construction practice in this country show costs per person, as of January 1951, ranging from $30 (for the Morrison Shelter in a basement) to $147 (for the strongest type reinforced concrete communal shelter for 30 persons). If costs on the average approach these higher figures, then substantial Federal aid will be needed if progress is to be made.

Federal Civil Defense Administration engineers believe that it should be possible for the Federal government to give more than 50 per cent, and indeed in the Klein bill, for parking-garage aid to cities, no firm formula was required. Some degree of local participation is recognized as necessary for full and intelligent cooperation, but it is suggested that the program be placed on a combination grant-and-loan basis with low interest rates, along the lines of the Lanham Act (community facilities for defense housing), Bolton Act (nurses' homes), and the Housing Act (public housing and urban redevelopment).

A complication in the present matching funds system is the requirement that these funds be allocated according to the proportion of the population of each state within critical target areas. New York City is currently requesting Federal aid for the construction of subway entrances which will offer a substantial addition to shelter supply. The Federal share of this project is estimated at $7,500,000, but if Congress should agree that this was necessary, it would have to make an appropriation of $75,000,000 in order for New York City to obtain no more than 10 per cent, even though no other requests had been made for the balance. It seems clear that a rigid formula of this type does not serve the purpose as well as a more elastic provision.

Industries should, in most cases, be expected to take care of the provision of protective construction for their own personnel and facilities. Yet industry is better able to put up matching funds, and also it can obtain authorization for rapid amortization of its expenses for protective construction under a certificate of necessity, charge the amount off as a business expense, or, if it prefers to work through the local government, charge the amount off as a contribution. These points re-emphasize the importance of a flexible formula, under which the greatest needs can be served first.

Pertinent to the general study of costs of a shelter program is the Lehigh University report on AN ANALYTIC METHOD FOR ESTABLISHING A SHELTER PROGRAM.[43] This is a study of mathematical probability, testing

[43] See footnote page 48.

a series of assumptions to examine some broad policy questions: what design of communal shelters; how strong to build the shelters; how to obtain maximum protection from limited funds; and what returns in terms of casualties avoided may be expected for various levels of expenditure. The first part of this report makes the assumption of random aiming of atomic weapons, and it has already been noted that the results are startlingly specific on the optimum thickness of reinforced concrete. Where aimed bombing is assumed, the results are less specific, but there is a clear indication that maximum economy will be gained if the shelter program is carried out completely at one time in any one community. Methods are presented for studying the investment needed for a desired level of protection, or the best designs for a given amount of money. In a discussion of the relative economies of large shelters versus small ones, it is indicated that distinct gains in economy and efficiency may result from added warning time.

The Lehigh report is not intended to be taken literally, but is rather a working tool for just such a policy planning group as is now being created within Federal Civil Defense Administration. It has certain limitations. It is based entirely on the assumed use of certain specific communal shelters; protection by existing structures can be worked into the procedures but not easily. Hiroshima data have been used as the basis for casualty assumptions, as have the data from THE EFFECTS OF ATOMIC WEAPONS; casualty estimates may therefore be on the high side. In the consideration of target bombing, the aiming points, their dispersion, and their probabilities had to be estimated; it is not clear how this was done. Quantitative results are all in terms of specific shelter designs proposed by the Lehigh group; this does not invalidate the general conclusions. Finally, by its very nature, the report can give no help on the problem of allocating funds between shelters and other forms of protection (such as military defenses, dispersal measures, or fire measures), or on the political and psychological factors of shelter design and location which are likely to be little affected by logic or mathematical probability. In sum, this represents not a complete method of establishing a shelter program but rather a refined analysis procedure to be used to test policy assumptions. As soon as data are available on methods of using existing buildings and other structures for protection such as those studied in the Selected Area Study in New York, they should be reviewed by procedures of this sort to determine whether it is possible to give protection at adequate standards for substantially lower cost than has been assumed heretofore.

d. Legal Problems and Tax Inducements

The Federal Civil Defense Administration is engaged in exploring various tax and other inducements which may be used to further

the construction of shelter areas, and the legal and other complications which will be faced when the agency is given funds to go ahead with its shelter programs. Inducements include accelerated depreciation, special allowances of controlled materials, deductibility of construction cost as a business expense, etc. Problems are equally variable: protection against liability for the building owner who throws shelter areas open to the public, power of government to require construction of a public shelter in a private building or to condemn an easement of some sort to permit public access to good existing shelter, the form of cooperation agreements for the sharing of shelter costs between public and private groups, etc. These measures are not always effective in an impartial way; the apartment house owner who is losing money will not be overjoyed at the possibility of deduction of business expenses. The home owner is not influenced by the possibility of increased rent for increased protective services. Nevertheless, all of these possibilities warrant examination, and there must eventually be a political determination of the most effective methods of using them.

For the present, the Federal Civil Defense Administration is attempting to do as much as possible through persuasion and advice. Insurance and industrial groups have been called to participate in conferences in the hope that they would take the initiative in pushing sound protective measures. Suggestions for building code provisions have been discussed with the Bureau of Standards and the National Institute of Municipal Law Officers. Cooperation of all sorts with interested local men has been freely offered.

PROJECT EAST RIVER believes that for major new buildings, the method called for is not persuasion but requirements of adequate standards in the interests of public safety through building codes and financial controls. Over a period of years, a substantial addition to shelter resources can be made in this way, and at slight additional cost. If the costs of providing shelter in existing buildings is as low as indicated in the Selected Area Study in New York, serious consideration should be given to flat requirements that it be provided.

Requirements of this sort might conceivably be enforced directly by the Federal Government under its war powers, but unless there is an extreme emergency, so radical a shift in our system of authority would be politically unacceptable. More acceptable would be the establishment of uniform state laws embodying protection requirements, to be helped to passage in the various state legislatures by publicity and pressure of many sorts, including Federal loans and grants and the background threat of some form of Federal action in a crisis. The provision of protection

measures through the amendment or passage of local ordinances is an extremly slow process, although it could be speeded by the joint promotional activity of special code organizations, informal building groups, insurance and banking concerns, and the Federal agencies dealing with local buildings. A program of war risk insurance, in which the rates were graded according to risk and reduced when measures were taken to reduce the risk, would be a powerful inducement.

Particularly with regard to fire, the dangers are such that hard-headed enforcement of protection measures is clearly called for. The present practice is that a property owner who neglects sound fire-prevention measures may do so, but he may have to pay additional fire insurance premiums on that account. Firestorm and conflagration are community-wide hazards and individuals should not be permitted to create such hazards. The fact that the property owner could insure against the hazards should not be allowed to influence the matter.

Some of the states have already indicated their belief that under existing state civil defense legislation they could already require fire and blast protective measures in all construction, so long as the requirements for existing buildings were logical, simple, and understood and desired by the public. The principal problem is to create a sharp awareness on the part of the public. It was to do this that PROJECT EAST RIVER recommended[44] that the Federal Government insist that adequate protection standards be provided in all buildings to be erected, financed, or otherwise assisted by Federal funds.

e. Special Problems for Administrative Determination

Several specific problems of administration of a shelter program deserve comment. The Federal Civil Defense Administration has taken the position (Bulletin 28 issued March 31, 1951) that it will not lend financial support to help build shelters unless they are open to the public. The basic civil defense law leaves this question unanswered. In many city areas, however, private individuals may have no desire to cooperate if it means opening their buildings to the public. Industrialists whose plants were relatively difficult to reach, on the other hand, might find it easy to say that they were open to the public. This situation requires careful policy evaluation.

The question of grade-labeling of shelters comes up from time to time. This is very necessary for the technician, and in the course of

[44] See footnote page 17.

years shelter areas may be raised substantially in grade, or abandoned as better areas become available. From the point of view of the public, no grade labelling should be permitted. In certain buildings, the best shelters available for the use of tenants may be relatively poor shelters, but they will nevertheless be considerably better than nothing. The point of designating shelters is to direct people to the place where they will have the best chance of surviving uninjured. Only the technicians should be concerned with the exact degree by which this best chance varies from the standards.

Many people ask questions about the use of basements. Except in unusual circumstances, or under attack by chemical weapons, basements are likely to provide relatively good shelter areas. They require protection against overhead collapse and the provision of alternative exits, but they are often able to be made quite secure against atomic attack at relatively little cost. The same reasoning applies to subways and to a number of other structures likely to be found in city areas, such as underpasses and tunnels. In individual homes, there may be occasions when basements will be unwise locations, but usually they offer the best starting point in searching for protection which, under current Federal Civil Defense Administration policy, must be provided in most residential areas by the home owner himself. A manual of design suggestions to help the home owner is currently in the process of publication.

The problem of the so-called "dual-purpose" structure is not easy. Present legislation makes it clear that no aid can be given if the structure can be made self-liquidating, and that where aid is given, it extends only to that part of the structure which is directly attributable to civil defense. Bowling alleys and subways are examples of structures which can easily be protected underground and which provide open space not likely to become cluttered up in normal operation. The building which has only partial justification for either peacetime or wartime should not be given aid because of its dual deficiencies; but projects which combine necessary civil defense facilities with genuine peacetime uses should be encouraged.

In general, each proposed improvement for which a dual purpose is claimed and for which a public subsidy is required because of the defense features involved should meet one of the following three requirements:

(1) The improvement should be eligible for construction as a normal peacetime structure or facility without the addition of the defense features for which subsidy is required (example, an office building the foyer or basement of which is specially designed as public shelter for persons who do not normally work in the building).

(2) The improvement should be justified by defense needs alone, but can have nondefense uses built into it (example, if a special structure must be built as a public shelter, peacetime uses should be built in, such as a bowling alley, a pedestrian underpass, a shopping arcade).

(3) Where the improvement cannot be justified either by peacetime needs or for defense purposes alone but only by a combination of both, defense costs should not exceed the minimum cost of achieving the same defense benefit by the least expensive alternate method. This type of project is open to "pork-barrel" treatment, and the test suggested should result in very few being constructed (example, the proposed Second Avenue Subway in New York City which, let us assume, the City cannot afford to build without a Federal subsidy. The test should be whether a Federal shelter program for the area concerned could be accomplished for any less Federal cost than by helping New York build its subway).

f. Need for Federal Leadership by Applying Protection Standards to Federal Buildings

One of the most effective means for implementing a shelter program can be the example set by the Federal Government with regard to its own buildings and those which it rents or assists financially. It is none too soon for these buildings to provide shelter spaces for their occupants, for their construction to give the added strength of a rigid frame, and for the buildings to provide high standards of fire resistance and fire prevention measures like compartmentation and automatic sprinklers supplied by independent water supplies. The vital records which are an important part of many agencies should be dispersed for storage purpose, and finally, the location of the buildings themselves should follow the standards proposed for defense by space.

Such an example by the Federal Government would not only provide invaluable information and practical administrative experience, but also would help to demonstrate locally the meaning, cost, and value of protection standards. Policies which might never be settled if they had to be discussed in the abstract could soon be given sharp form in the eyes of the public and of the Congress.

6. THE NEED FOR OVER-ALL CIVIL DEFENSE PLANNING

a. Government Agency Coordination

Coordination of structural measures with other protection measures is of the utmost importance. A beginning in this direction has been accomplished by the Federal Civil Defense Administration in creating

in the Engineering Services Division a small planning branch, which has also been assigned the task of working with city planning, zoning, and building code groups to help improve local measures of protection; and of working with the Housing and Home Finance Agency, the Federal Security Agency, the National Security Resources Board, and the many other Federal agencies which are concerned with various parts of this broad problem. Until the present, the planning branch has concerned itself largely with measures to be taken in the field of post-attack rehabilitation, but its efforts are to be turned also to the planning of long-range preventive measures.

b. Structural Protection as an Element in National Defense

A real need exists in the field of urban protection for overall planning in which the problem is viewed as a whole and the component parts are worked out on the basis of a coordinated framework of assumptions and policy decisions. This is probably a reflection of the need for defense planning on a comprehensive basis at other levels: the choice between military and nonmilitary expenditures, the choice between preventive and disaster-relief measures, within the field of prevention, the choice of most effective and most economical measures, and within the selected area of prevention, the balance between pertinent elements. It was observed that decisions on the allocation of funds for protective construction are intimately connected with decisions on the steps to be taken to reduce congestion and provide space, and on the measures to be enforced to reduce the danger of fire. Yet these three factors have so far been considered in almost entirely separate compartments, two in different branches of the Federal Civil Defense Administration and one in the National Security Resources Board. Furthermore, as has been pointed out above, the major effort of the Federal Civil Defense Administration on the problem of fire has been devoted to fire-fighting measures rather than prevention and planning measures.

Within Engineering Services Division of the Federal Civil Defense Administration, an effort has been made to bring together skilled technicians on the various phases of the structural protection problem, whether they are concerned with the shelter program or the protection of utilities and services. Furthermore, a Research and Development Division has just been set up in Engineering Services to provide coordination and to work for a comprehensive and hard-headed type of research program. These are basic steps on the way to understanding of technical possibilities and of broad economic, social, and political considerations which may lead eventually to the formulation of sound policy.

IV SUMMARY OF RECOMMENDATIONS

The Panel submits the following recommendations for reducing the vulnerability of concentrations of people and industry in the United States:

1. DEFENSE STANDARDS FOR URBAN DEVELOPMENT

a. Urban areas of the United States should be classified into Class I Vulnerable Urban Districts and Class II Vulnerable Urban Districts by the National Security Resources Board or other appropriate Federal agency designated by the National Security Resources Board. (For definitions of Vulnerable Urban Districts see page 21.)

b. No new defense supporting industry should be located in any Class I or Class II Vulnerable Urban District or within 10 and 6 miles, respectively, of any such district. (For explanation of this recommendation see pages 28 and 29.)

c. Housing, commercial, and nondefense industrial densities should be reduced in Class I Vulnerable Urban Districts and all new construction in such districts should be built to blast- and fire-resistant standards. (For details of density and structural standards in Class I Vulnerable Urban Districts see pages 27, 54, and 61.)

d. Housing, commercial and nondefense industrial densities should not be increased in Class II Vulnerable Urban Districts, and all new construction in such districts should be built to blast- and fire-resistant standards. (For details of density and structural standards for Class II Vulnerable Urban Districts see pages 28, 57, and 61.)

e. Public and institutional buildings erected within any metropolitan area (as defined by the United States Census Bureau) which contains a Vulnerable Urban District should be built to blast- and fire-resistant standards. (For details of such standards see pages 54 and 61.)

2. DIRECTION OF PUBLIC ENTERPRISE IN CONFORMITY WITH DEFENSE STANDARDS

Federal, state, and municipal spending, financing, and construction activities in urban areas should be brought into line with minimum standards for urban development and redevelopment on a metropolitan area basis. (For recommended Federal action see pages 31 and 99.)

3. REGULATION OF PRIVATE ENTERPRISE IN CONFORMITY WITH DEFENSE STANDARDS

Urban land use and building controls exercised under state police power (such as zoning and building codes) should be exercised on a metropolitan basis and brought in line with minimum standards for urban development and redevelopment. (For recommended state and municipal action see page 36.)

4. RECOMMENDATIONS FOR SPECIAL PROGRAMS

a. The Federal Civil Defense Administration survey for shelter in existing structures, modified where indicated by local conditions, should be completed as soon as possible in the Vulnerable Urban Districts, if necessary by the use of Federal funds. (Survey programs and recommendations are discussed on page 84.)

b. As the survey proceeds, the best available shelter space in existing structures should be designated (with minor alterations made where necessary) for the populations of the Vulnerable Urban Districts. (For explanation of this recommendation see pages 51 and 89.)

c. Upon completion of the survey, a study should be made of the cost and feasibility of a comprehensive shelter program to provide a reasonable level of protection for those within Vulnerable Urban Districts. (Recommended shelter program is discussed on page 92.)

d. The Federal Civil Defense Administration should designate and map the potential fire-storm areas and aid the cities in formulating instructions for the people in the areas on escape routes and the fighting of the small fires which contribute to fire storms. (For explanation of this recommendation see page 32.)

e. *The several states should establish and finance, if necessary with Federal aid, a metropolitan district planning commission for each metropolitan area (as delimited by the Bureau of the Census). Such commissions should prepare land-use plans in cooperation with local municipal authorities, including in such plans defense standards of spacing and arrangement of different categories of land use and density of population. Such commissions should also be given power to review local zoning ordinances, subdivision plans, building codes and permits to extend municipal services with such limitations on full local authority as may be appropriate in each state. (For explanation of this recommendation see page 42.)*

f. *A National Commission on Intergovernmental Relations, or any alternative organization that will produce solutions to municipal financial problems arising out of defense requirements, should be authorized and financed by the Federal Government. (For explanation of this recommendation see page 45.)*

g. *If a program of war risk insurance is undertaken by the Federal Government, no new structures should be insured unless they conform to urban defense standards, and premium rates on existing and new insurable structures should be graded according to location, with the highest rates set within Vulnerable Urban Districts. (For explanation of this recommendation see page 35.)*

h. *Federal grants-in-aid should be established for park areas to reduce fire-storm, and conflagration possibilities. (For explanation of this recommendation see page 33.)*

5. RESEARCH

a. *An unclassified special manual on atomic weapons effects in a form suitable for use in the preparation of metropolitan land use plans, building codes, zoning ordinances and other regulatory ordinances should be prepared. (For explanation of this recommendation see page 30.)*

b. *Research is needed on the following subjects relating to defense by space:*

(1) Regional relocation (See page 31.)

(2) War risk insurance (See page 35.)

c. Research is needed on the following subjects relating to structural protection:

(1) Blast effects in loading building surfaces (See page 75.)

(2) Vulnerability of standard building types (See page 75 and 76.)

(3) Casualties to personnel in buildings (See page 77.)

(4) Resistance of structural elements (See page 78.)

(5) Windows and glass (See page 79.)

(6) Protection of utilities and special facilities (See page 79.)

(7) Flooding and structural effects of underwater and underground bursts (See pages 79 and 80.)

d. Research is needed on the following subjects relating to protection against fire effects:

(1) Initiation, support and spread of fires under modern wartime conditions; fire storm technology (see page 79.)

(2) Measures to stop or limit the spread of such fires (See page 79.)

(3) Provision of emergency water supplies in buildings and cities for wartime fire protection (See page 79.)

SELECTED AREA STUDY

Appendix V-A
to
Part V of the
Report of

PROJECT EAST RIVER

September, 1952

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SELECTED AREA STUDY

1. INTRODUCTION.

PROJECT EAST RIVER was initiated to examine all aspects of civil defense and to report on the optimum combination of measures that should comprise the civil defense component of the national security. Throughout the discussions concerning the formal contract for the study and the terms of reference and in the briefings by the supporting agencies, it was understood that PROJECT EAST RIVER would utilize the pertinent data and information that existed and were available. PROJECT EAST RIVER was not expected to undertake research in the sense of conducting experiments or field tests and exercises to develop new basic data. The Selected Area Study is an exception to this rule.

1.1 THE INITIATION OF THE SELECTED AREA STUDY AND ITS RELATIONSHIP TO THE REMAINDER OF PROJECT EAST RIVER.

Three investigations of PROJECT EAST RIVER led to the initiation of the Selected Area Study. A subgroup of the Panel on Atomic Threat (see Part III, "The Destructive Threat of Atomic Weapons") undertook a critical review of the casualty estimates that were available and that were the basis of much of the planning and stockpiling programs for civil defense. The reliability of these estimates was crucial to the work of the Panel on Health and Welfare (see Part VIII, "Civil Defense Health and Welfare"): The Panel on Warning and Communications (see Part VII, "Warning and Communications for Civil Defense") had an interest in casualties from the point of view of the dependence of the number and kinds of casualties on the warning time. Finally, the Panel on Protection (see Part II-B, "Federal Leadership to Reduce Urban Vulnerability" and Part V, "Reduction of Urban Vulnerability") was interested in the casualty problem, which is closely related to the shelter program, to standards or codes for improved construction and spacing, and to estimates of the physical damage that an average United States city would suffer from an A-bomb attack.

Members of the Shelter Division of the Federal Civil Defense Administration discussed informally with members of PROJECT EAST RIVER the difficulty of making Congress and the public fully aware of the need for shelters and of enlisting the support and backing of fiduciary

institutions, such as the large life insurance companies, for the construction of both dual purpose shelters and adequate shelter areas within otherwise standard buildings. The information presented to PROJECT EAST RIVER on shelter needs to reduce casualties from an A-bomb attack seemed too general to elicit wide support. Some members of PROJECT EAST RIVER suggested that a typical American city be used as a "guinea pig" for a more detailed study of shelter needs and possible casualties. They felt that the use of a special area, as a particular example, would help to focus attention on the need for adequate civil defense measures. A special study was recommended to point up the need for adequate warning, by measuring the difference in casualties between no warning and adequate warning. The study might reveal the extent of the need for shelters and throw some light on the types of shelters that would be required, by measuring the difference in casualties between having shelters and not having them. The added interest of the representatives of the Shelter Division, Federal Civil Defense Administration, led to the decision to undertake a special study.

1.2 OBJECTIVES.

Once the decision was made to undertake a detailed study, with casualty estimates as the ultimate objective, it was evident that with little additional effort the study could be made to produce material of value to other aspects of civil defense. The objectives were modified in minor respects as the study progressed. The general objectives were constant throughout the study and were as follows:

1.2.1 Analysis Methods. Numerous methods or procedures have been proposed for estimating probable physical damage, casualties, and shelter requirements of an area. Some of these methods require what is essentially a street-by-street, building-by-building inspection and census. Other methods are entirely statistical in nature. Between these extremes there are various combinations of statistical treatment and individual inspection. It was hoped that the Selected Area Study might clarify this subject, particularly through an indication of the precision or degree of reliability of the statistical methods. In order to have a foundation based on well-tested methods, it was agreed that the Federal Civil Defense Administration inspection, reporting, and rating forms and procedures would be employed by PROJECT EAST RIVER for all portions of the study having to do with individual inspections.

1.2.2 Shelter Needs and Capabilities. The study is intended to reveal the nature of the shelter requirements with various assumptions concerning the warning, such as "no warning" and "15-minute warning." The type of shelters required depends on factors such as the location and

spacing between the shelters and whether the shelters are for long-time occupancy or are to be austere, short-time occupancy affairs. Shelter capabilities include both a measure of existing areas that provide adequate shelter as well as consideration of new construction or alterations to provide shelter areas. This latter problem also includes a consideration of relative costs.

1.2.3 Estimates of Physical Damage. Casualty estimates, the ultimate objective, are dependent to some extent upon estimates of the physical damage an A-bomb attack might cause. Hence, the study necessarily requires an examination of the probable physical damage. Included in these physical studies are blast effects, contamination, and fire.

1.2.4 Estimates of Casualties. It seemed desirable to break down the casualty estimates by cause and effect in order to reveal the number of casualties requiring attention and, through the identification of the factors producing each type of casualty, indicate which causes would be most susceptible to preventive or mitigative measures.

1.2.5 Relative Importance and Costs of Civil Defense Measures. A definitive determination or estimate of relative importance and costs of civil defense measures requires consideration of economic and logistic factors beyond the competence of the study group. On the other hand, the study is intended to indicate, at least in general terms, the relative importance of measures or factors bearing directly on the number of casualties, such as warning time, prompt determination of location and type of explosion, direct communications between the civil defense control center and the public (in shelters), meteorological surveys in the yellow alert period, public education, fire prevention, and shelters.

1.3 SELECTION OF THE AREA; SOURCES OF INFORMATION.

The search for a typical American city was abandoned. During the briefings it became apparent that a typical American city did not exist for our purposes. Even if we selected a city large enough to measure the effects at different distances from a bomb burst, it would be difficult to make significant comparisons because of internal variations in the characteristics of different parts of the city.

Attention was called to a recent and detailed study of the area in New York City that lies between 59th Street and 72nd Street and between Third Avenue and the East River. The area consists of 47 blocks (260 acres) and is completely developed. The population in the area is approximately 35,000. The study, which was made under the aegis of

ASSIGNED BLOCK NUMBERS
IN SELECTED AREA STUDY

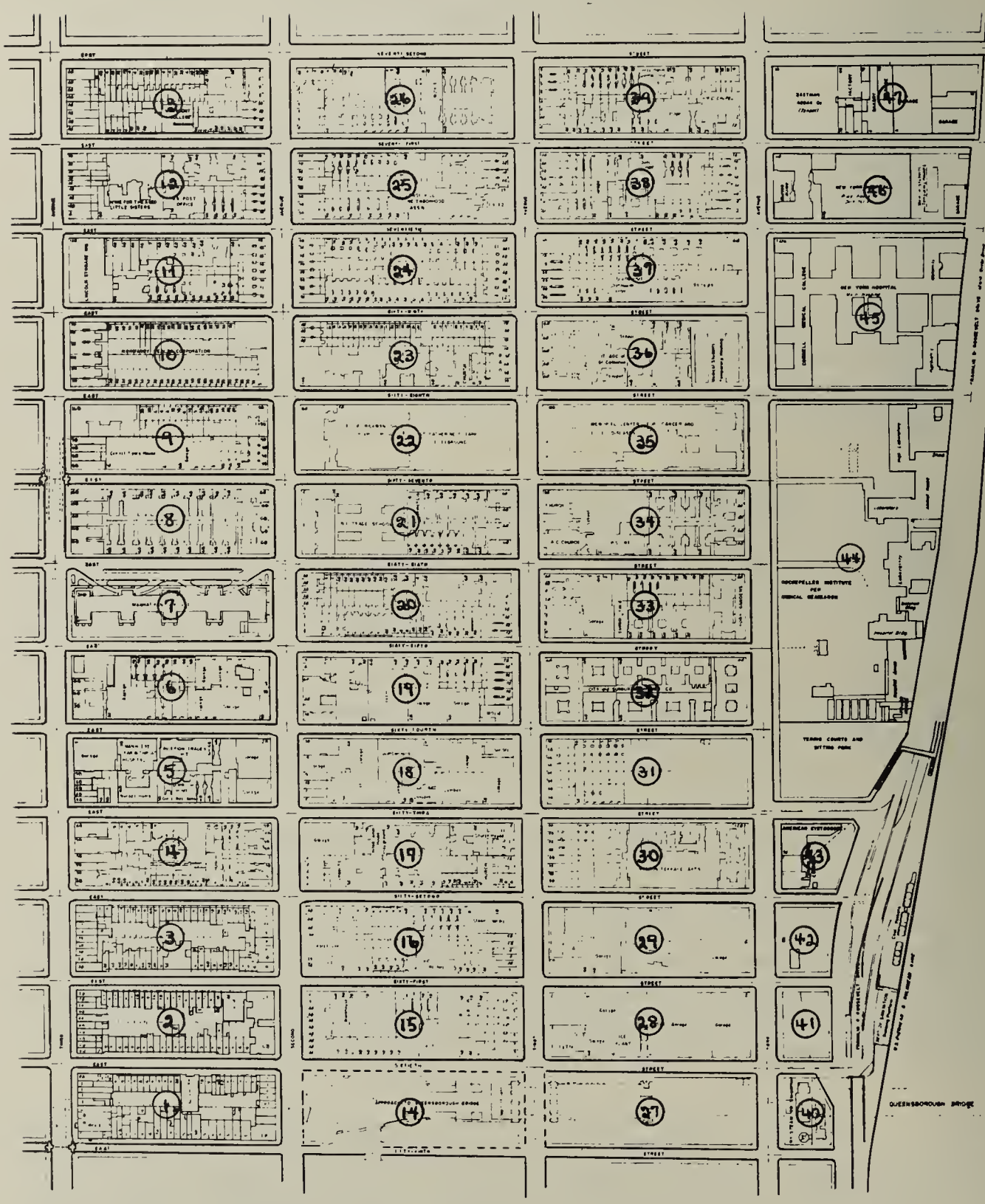

FIGURE 1a

Air view of the selected area in Manhattan; the East River and Queensborough Bridge at lower right.

FIGURE 1b

Memorial Hospital, the New York Hospital, the Rockefeller Institute, City and Suburban Homes, Inc., and the New York Life Insurance Company, resulted in the preparation of a series of maps which shows the characteristics of the buildings in this area in great detail, that is, the zoning, age of building, and land use. Figure 1A is a map showing this area, and Figure 1B is an aerial photograph. The blocks are numbered arbitrarily for the use of PROJECT EAST RIVER, as shown on the map.

Instead of trying to find a typical city and studying the bomb effects therein at different distances from a bomb burst, the Panel decided to use this special New York City area to estimate the effects of bomb bursts at different distances from the area. This procedure permitted a more detailed analysis of the buildings in a small area than would be feasible if an area of many square miles were involved.

This special area study, which covers slightly less than one-half square mile, filled the need for a typical area as it contained many of the features found in our larger cities, namely, one-story stores or commercial buildings, walk-up apartments, multi-story apartments, schools, churches, hospitals, storage warehouses, theatres, etc. There were no large department stores and concentrations of office buildings and practically no detached single dwellings or large industrial plants.

Data were available from the United States Bureau of Census on a block-by-block basis for 1950. These data reflect residential populations, not daytime distributions. In order to use the available census data, it was decided to work on the basis of a nighttime (two a.m.) attack. Thus, buildings of the type found in a concentrated business district were not needed, and the on-street nonresident population would be insignificant. Also, since detached single dwellings are most common in suburbs, they do not represent the most likely kind of target.

For the phases of the study concerned with A-bomb effects, the official publication "The Effects of Atomic Weapons" (June 1950, revised September 1950) and the reports of the Physical Damage Division of United States Strategic Bombing Survey on the A-bomb effects at Hiroshima and Nagasaki (May 1947 and June 1947, respectively) were primary sources. As these sources as well as all other essential material involved in the study were unclassified, an early decision was made to divorce the Selected Area Study from any classified material. Several compilations of data from the United States Strategic Bombing Survey Reports that were published in tabular or graphic form in a secret study were not useful because downgrading of the compilations was delayed and came very late in the course of the study. In a few instances, specific items in "The Effects of Atomic Weapons" were checked against a more recent re-

stricted publication "Radiological Defense-Volume II" (November 1951) to make certain that recent tests did not indicate that revisions or corrections were of such magnitude that the results of the Selected Area Study would be vitiated if based on only the earlier unclassified data. No exceptions were found, and thus the Selected Area Study employed only unclassified material that is open to the public and available to all civil defense workers.

1.4 PARTICIPANTS.

The Selected Area Study was carried on by a number of persons, many of whom had no other affiliation with PROJECT EAST RIVER. Various amounts of time and effort were devoted to the study, and no hard, firm line may be drawn between those who "worked" on the study and those who "advised and consulted." The following lists are included both to indicate those to whom credit is due for whatever value the study may have and also to indicate the many diverse interests and specializations incorporated in the study:

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S. T. Stack—New York Fire Rating Board
S. S. Tompkins—Consolidated Edison Company of New York
Stephen F. Voorhees—Voorhees, Walker, Foley and Smith

The study has also benefited from the work done in connection with other PROJECT EAST RIVER reports, particularly Part III, "The Destructive Threat of Atomic Weapons", and Part V "Reduction of Urban Target Vulnerability."

1.5 PROCEDURES.

In subsequent portions of this report the detailed procedures employed for the various phases of the study will be described. The general approach will be outlined here as well as the basic assumptions common to all portions. As the study was an exploration of new fields for most of the people involved, there was no a priori basis for deciding what data would ultimately prove to be important, what would have little relevance, and hence would need to be known with only moderate precision. Accordingly, it was decided to complete each phase of the study with care and in detail, thereby insuring that any unforeseen developments might profit from the earlier steps without retracing any of the work.

The time of attack was assumed to be two a.m. with no differentiation as to the time of year. Ten bomb drops were studied in pairs consisting of a nominal 20-kiloton bomb and an 8X or 160-kiloton bomb for each of five ground-zero points assumed:

(1) Over the center of the area;
(2) One-half mile from the edge of the area;
(3) One and one-half miles from the edge of the area;
(4) Four miles from the edge of the area;
(5) A drop in the East River.
(The fifth drop is treated separately in Section 3.8.)

As the selected area is small, 3800 feet in length and between 2700 and 3300 feet in width, it was believed that a simplifying assumption could be made, namely, that conditions at the edge of the area nearest the bomb burst prevail throughout the area. The over-all effect of this assumption is to make all estimates of physical damage and number of casualties too large. On the other hand, evidence from Hiroshima and Nagasaki and subsequent controlled tests indicate that structures of supposedly the same construction and located at the same distance from the ground zero did not react in identically the same manner; frequently the variations were larger than the average gradation through an increase of range of one-half mile. Thus, the assumption introduces no large inaccuracies. In a few cases, interpolations were made where the effects changed markedly between the near and far sides of the area. These cases are discussed in more detail in the relevant sections of the report.

The assumption was made that the four nominal air bursts occurred at 2000 feet and the four 8X bursts occurred at 4000 feet. No attempt was made to study the effect of height of burst. Throughout the report there is the implicit assumption that meteorological conditions are normal, at neither extremes of heat or cold, cloudy or clear, humid or dry.

2. THE SHELTER SURVEY.

The Shelter Division of the Federal Civil Defense Administration has prepared several pamphlets for the guidance of local civil defense personnel in making shelter surveys. "Shelter from Atomic Attack in Existing Buildings, Part I—Survey of Shelter Areas," and "Part II—Improvement of Shelter Areas" describe various aspects of the problem. These documents suggest forms to be used in rating shelter areas and summarizing such data. These forms were adopted for the Selected Area Study. Reference should be made to the Federal Civil Defense Administration pamphlets for a general discussion of the problem, for terminology, and for an explanation of the meaning or significance of the numerical ratings of inspection forms.

In discussions among members of the study group, including representatives from the Federal Civil Defense Administration, the major difference of opinion was on the value of preliminary estimates of shelter "probabilities" based entirely on a desk study of maps and similar printed information. There was complete agreement that a visual inspection was the only valid procedure to be followed in determining whether or not any specific site provided adequate shelter. It seemed that at least part of the misunderstanding that has grown up concerning the relative merits of various analysis methods is based on a lack of mutual agreement on the meaning and purpose of shelter "probabilities." As many of the people involved in shelter surveys are engineers who are used to working with exact measurements and precise numbers, a statistical approach based totally or in part on probabilities would naturally be viewed with some misgivings. This appears to be the crux of the issue.

2.1 PROCEDURE.

The analysis method proposed in the Federal Civil Defense Administration pamphlets essentially discounted the value of shelter "probabilities" and placed full reliance on visual inspections. There is no question that this method gives a reliable result. Whether or not the precision is greater than necessary is a moot point. That the method demands a considerable expenditure of manpower is admitted by all. A crude analogy has been made to "shooting blackbirds on a rail fence with a ma-

chine gun." The study group did not have the manpower at its disposal to survey the selected area in strict accordance with the Federal Civil Defense Administration method. Neither did the Shelter Division of the Federal Civil Defense Administration, and hence, it has not been possible to make a direct comparison between the results of a Federal Civil Defense Administration analysis and the combination statistical probability—visual inspection analysis adopted by the study group. As developed in Section 2.4 which follows, it has been possible to throw some light on this subject; the admitted weakness is that the sample of 60 buildings should have been larger in order to have permitted an absolutely firm conclusion.

The procedure adopted by the study group consists of the following:

(1) A statistical estimate of shelter probabilities, based entirely on a desk analysis of maps and other printed information.

(2) Visual inspection of a sampling of the probable shelter sites.

2.2 SOURCES OF INFORMATION.

In the shelter survey, the following sources of information were available:

1. New York Life Insurance Company maps of the area prepared for another study. (See Section 1.3) These maps showed:

(a) Zoning
(b) Age of buildings
(c) Assessed valuation (not used)
(d) Prospective new constructions (not used)
(e) Land use.

2. 1950 Census figures, compiled by blocks, for the domiciled population of the area.

3. Sanborn Fire Insurance Maps[1]

These maps diagram by color and symbols detailed information of building characteristics, including outline of area, type of construction, and number of stories.

[1] Sanborn Map Company, 10 Cedar Street, New York City. Sanborn maps are kept current on essentially an annual basis for all cities of more than 25,000 population, exceptions being smaller places having very little construction activity. Maps are available for many localities as small as 2000 population. These maps are generally used in larger towns and cities at such offices as the building inspector, the city engineer, or the fire department, and are available for purchase from the Sanborn Map Company.

4. Knowledge of the area and building types acquired through prior training and experience of some members of the study group.

2.3 BUILDING TYPES.

Is was found that the buildings in the area could be grouped in the following categories as to type:[1]

Type 1

Protective residential—Fireproof steel or concrete frame, more than six stories high, with reinforced concrete floors and, generally, brick closure walls 8 or 12 in. thick supported on structural steel members at each floor. Steel framing is either completely fireproofed or the fireproofing under floor slabs extends down to lower flange of the floor beams and girders. Interior partitions are usually three- or four-inch thick gypsum or plastered cinder block.

Type 2

Semi-protective residential—(New-law tenements) Brick wall-bearing construction, usually six stories high. First floor is reinforced cinder concrete of three- to four-inch thickness supported on steel members and fireproofed. Roof and floors above first floor are framed in wood.

Type 3

Nonprotective Residential

(a) Converted multiple dwellings
(b) One- and two-family houses
(c) Old-law tenements

Brick Walls—four to six stories high with cellar and basement (half below grade); usually built in rows with brick party walls between buildings. Floors and roofs wall-bearing wood construction.

Type 4

Industrial

This category was not included in the study.

[1]A block-by-block building census of the selected area gave the following results: Type 1—14; Type 2—105; Type 3a—415; Type 3b—104; Type 3c—339; Type 4—hospitals and industrial buildings not included in study; Type 5a—3; Type 5b—23. By comparison, in the city of New York there are estimated to be: Type 2—56,000 new-law tenements; Type 3a—15,000 converted multiple dwellings; type 3b—490,000 one- and two-family dwellings; Type 3c—54,000 old law tenements. In the report from which these figures were taken, no data were given for type 1, 4, and 5.

Type 5

Institutional
(a) Fireproof
(b) Nonfireproof

A summary of buildings in each classification was made for use in making estimates of physical damage and casualties.

2.4 PUBLIC SHELTERS AND SHELTER REQUIREMENTS.

Only five public shelters with a combined capacity of 1070 persons were listed in this area by the New York City Office of Civil Defense at the time the study was started. Four others with an additional capacity of 280 persons were waiting the consent of owners. There are no transit subway stations or tunnels in the area which could be considered as possible public shelters. A block-by-block listing of the people housed in each of the first three types of buildings (described in Section 2.3) gave an indication of the shelter requirements. This survey indicated that there were approximately 5000 people in protective buildings, 10,000 in semi-protective, and 20,000 in nonprotective buildings.

A list of all "probable" public shelter sites was prepared from an analysis of the maps and other published information, Table 1. The list contained a total of 60 areas which should provide adequate public shelters with little or no alteration.

Table 1

List of Buildings Which Should Be Investigated for Possible Public Shelter Areas*

Block No.	*Address*	*Stories***	*Use*
3	227 East 61st St.	5B	Apt.
4	200 E. 63rd Street	6S	Apt.
4	234-238 E. 63rd St.	5B	Apt.
4	240 East 63rd St.	5S	Apt.
4	1185-1189 2nd Ave.	5S	Apt.
6	1099 & 1103 3rd Ave.	6S	Apt.
7	Manhattan Houses	20B	Apt.
8	Entire Block—30 Bldgs.	6B & 6S	Apt.
9	200-210 E. 68th St.	16S & 16	Apt.
9	1293 2nd Ave.	5S	Apt.
11	1191 3rd Ave.	14B	Storage
12	207 E. 69th St.	10	Apt.
12	224 E. 71st St.	6B	Apt.
12	230 E. 71st St.	6B	Apt.

Block No.	*Address*	*Stories***	*Use*
13	242 E. 72nd St.	16	Apt.
13	221 E. 71st St.	6	Apt.
13	222 E. 71st St.	7B	Dorm.
14	Queens Boro Bridge	Approach	
16	1166 2nd Avenue	14	Storage
16	330 E. 62nd St.	6	School
16	304-308 E. 62nd St.	6B	Apt.
19	338-340 E. 65th St.	6B	Apt.
20	324-326 E. 66th St.	6	Apt.
20	348-356 E. 66th St.	6S	Apt.
21	310 E. 67th St.	3B	School
21	225 E. 66th St.	3	School
21	332-348 E. 66th St.	6	Apt.
21	1225-1229 1st Ave.	6S	Apt.
21	331 E. 65th St.	5	Apt.
21	335-341 E. 65th St.	6	Apt.
22	Julia Richman H. S.	5B	School
22	Julia Richman Gym	6B	School Gym
23	315 E. 68th St.	16B	Apt.
23	329 E. 68th St.	9B	Apt.
23	333 E. 68th St.	15B	Apt.
23	347 E. 68th St.	6B	Apt.
25	325 E. 70th St.	5	Institution
25	322-328 E. 71th St.	6B	Apt.
26	320 E. 72nd St.	18B	Apt.
26	334-342 E. 72nd St.	16B	Apt.
26	305 E. 71st St.	6B	Apt.
26	357-361 E. 71st St.	6B	Apt.
28	409 E. 60th St.	4	Ice Mfg.
30	E. 62nd St.—E. 63rd St.	12B	Apt.
32	E. 64th—E. 65th St.	6B	Apt.
33	417-433 E. 65th St.	6B	Apt.
33	1215-1229 York Ave.	6B	Apt.
34	419 E. 66th St.	5	School
34	426-434 E. 67th St.	6B	Apt.
34	1235-1241 York Ave.	6S	Apt.
36	417-419 E. 68th St.	6B	Apt.
36	1270 1st Ave.	6S	Apt.
36	420 E. 69th St.	3B	School
37	411-421 E. 69th St.	4B	Health center
37	412-420 E. 70th St.	5B	Apt.
37	422-434 E. 70th St.	6B	Apt.
37	1301-1307 York Ave.	6S	Apt.
38	411-417 E. 70th St.	6S	Apt.
38	416-418 E. 71st St.	6S	Apt.

Block No.	*Address*	*Stories***	*Use*
39	422-428 E. 72nd St.	5B	Dental Clinic
43	1160-1166 York Ave.	3B	Mfg.

*(a) No garages are included even though some of them are of fireproof construction, as the gasoline in the car tanks would be a great fire hazard.

(b) In some cases, there are more than one shelter area per building.

(c) Hospitals are not included as they are not making any provision for shelter areas for the surrounding population.

** B-basement; S-store

Each site was visited and relevant data were recorded on the inspection forms prepared by the Federal Civil Defense Administration. The data on these forms were rated in strict accordance with the Federal Civil Defense Administration rating procedure. Of the approximately 60 sites listed, only 55 were found to contain areas which might serve as public shelters. A few buildings were omitted because inspectors could not gain admittance. The following table shows a breakdown of these shelter areas into the categories described in the Federal Civil Defense Administration manual entitled "Shelter from Atomic Attack in Existing Buildings."

Category	*Buildings*	*Estimated Sq. Ft.*	*Persons @ 5 Sq. Ft. Each*
I	8	108,151	21,630
II	5	35,945	7,189
III	20	18,615	3,723
IV	22	261,364	52,273

It is obvious that the Category I shelters would not be adequate for the population of over 35,000 in the area. The estimated total capacity of Category I shelters would accommodate the occupants of the buildings in which they are located as well as the off-street population in the immediate vicinity, but full use of the estimated capacity could not be realized because the shelters are highly concentrated in eight buildings, not evenly distributed over the area, and because of lack of public access.

A decision had to be made as to whether alterations would be made to the Category II, III, and part of the Category IV potential shelter areas or to construct new public shelters. Examination of the factors involved led to the decision that small shelters offered the most practical solution. The details of this solution are discussed in subsequent portions of the report.

It is interesting to note that the inspection of over 60 sites resulted in the validation of Category I shelters in only 8 buildings, Category II shelters in only 5 buildings, Category III in 20 buildings and Category IV in 22 buildings. To have determined how many additional shelter areas existed than were predicted in the list of 60 would have required time-consuming inspection of the entire area. There is no reason to believe, however, that the list of 60 probable sites was biased either to omit potential sites or to include sites of very doubtful value. Hence, we conclude that a desk-type analysis should give an accuracy sufficient for most shelter program purposes.

The study made no further investigation of the public shelter problem. It was believed that many small shelters would provide a cushion of excess capacity to take care of any normal on-street population, for this particular area, in view of the fact that, in the day-time when the on-street population would be highest, part of the residential population would be distributed in commercial and industrial regions outside the selected area.

2.5 WARNING TIME.

Warning time is an important controlling factor in the shelter program. Thus, it was obvious that (a) if no warning was given, shelters would be of little or no use; (b) if only 5 or 10 minutes warning were given, people would not have time to dress and travel any distance to shelter; and (c) public shelters would be feasible only if a half-hour or more warning time could be anticipated. In other portions of the report of PROJECT EAST RIVER (see particularly Parts I, IIA, VI and VII) the need for adequate warning is discussed in detail. PROJECT EAST RIVER recommends steps to improve the chances of there being a warning of an hour or more. Hence, the study group might have proceeded with a large public-shelter proposal predicated on the assumption that considerable warning would be given. The decision to recommend instead a program of "small shelters" was based in part on the consideration that the "small-shelter" program would be effective with either a long- or short-warning time, whereas the "large-shelter" program could be effective with only long-warning time and would be vastly more expensive.

The importance of adequate warning is also discussed in subsequent portions of this report which deal with casualties and means of reducing casualties through appropriate measures, implemented in the interval between the first warning and the time of attack.

2.6 HAZARDS.

In developing a private or small-shelter program, the study group

made the decision that absolute protection could not be provided at a cost that was economically feasible. By absolute protection is meant protection against all hazards from a bomb-burst directly overhead, accompanied with any possible combination of unfavorable factors introduced by the enemy or as a result of natural phenomena. The principal human hazards are (a) thermal burns, (b) radiation (primarily gamma rays and neutrons), (c) blast effects (including both flying glass and other missiles and the crushing effects of falling buildings), and (d) fire, which is recognized as a major hazard, both through burns and asphyxiation. This fire hazard is of a special nature, however, as fire casualties are not a consequence of the bomb burst but of developments in minutes or even hours after the burst. The fire hazard is, therefore, discussed separately in the section dealing with physical damage, and burn casualties are not estimated in detail.

2.7 PRIVATE OR SMALL SHELTERS.

It was decided that an area at least 80 per cent below ground level, with overhead protection sufficiently strong to withstand falling debris and as dense as possible to shield occupants from radiation, would provide less than absolute but nevertheless worth-while protection. Several means of egress from the shelter areas would be essential in order to evacuate occupants quickly.

The cellars of most of the semi-protective and nonprotective buildings in the area appeared to offer space which generally met the requirements, except for the hazard of falling debris from the upper part of the building.

A desk-type study was made using maps, building plans, and similar published data. Spot checks were made for buildings of each type to make certain that no factors not shown in the printed matter would vitiate the plans derived from the desk-type study. By strengthening the floor over a portion of the cellar near the stair with easily procured materials, an adequate shelter against debris could be quickly provided at minimum expense. A typical space (12-foot strip across the center of the building) was decided upon which would safely accommodate the greatest occupancy to be found in each particular type of building instead of varying the size of the space to agree with the actual occupancies in each building. For buildings with high occupancies, more than one "typical" space would have to be converted to a shelter. This standardization by quantizing the shelter area simplified the preparation of estimates and would also greatly simplify the actual construction of shelters, if such a program were implemented. It also provided a further cushion of excess shelter capacity that is distributed more or less uniformly throughout the area. This was considered to be a desirable attribute of the private, small-shelter program.

2.8 SHELTER PLANS.

Generally, two types of first floor construction will include the great majority of nonfireproof buildings in the area, namely (a) reinforced cinder concrete slabs on semi-fireproofed steel beams and (b) wood flooring on wood joints of varying span. It was assumed that these floors were originally designed for a liveload of 40 psf as required by the New York City Building Code. Reinforcement of these floors to provide shelter areas in the cellar was designed to increase the loading to a liveload of 400 psf as suggested in "Shelter from Atomic Attack in Existing Buildings, Part II—Improvement of Shelter Areas" of the Federal Civil Defense Administration. This load will support the expected debris resulting from collapse of a brick wall-bearing building four or more stories high, with the structural members subjected to unit stresses about 30 to 40 per cent higher than normal design stresses. These allowable increases are somewhat lower than recommended to allow for deterioration of the structures from age, including rusting of reinforcement and drying out of timber. Separate plans were developed for shelters in each of the following types: (These are shown as Charts 1, 2, and 3.)

Shelter Type 1.

"Brownstone front" residence or converted multiple dwelling (types 3a and 3b)

Shelter Type 1A covers approximately half the area of Type 1 with some reduction in costs.

Shelter Type 2.

Old-law tenement (Type 3c)

Shelter Type 3.

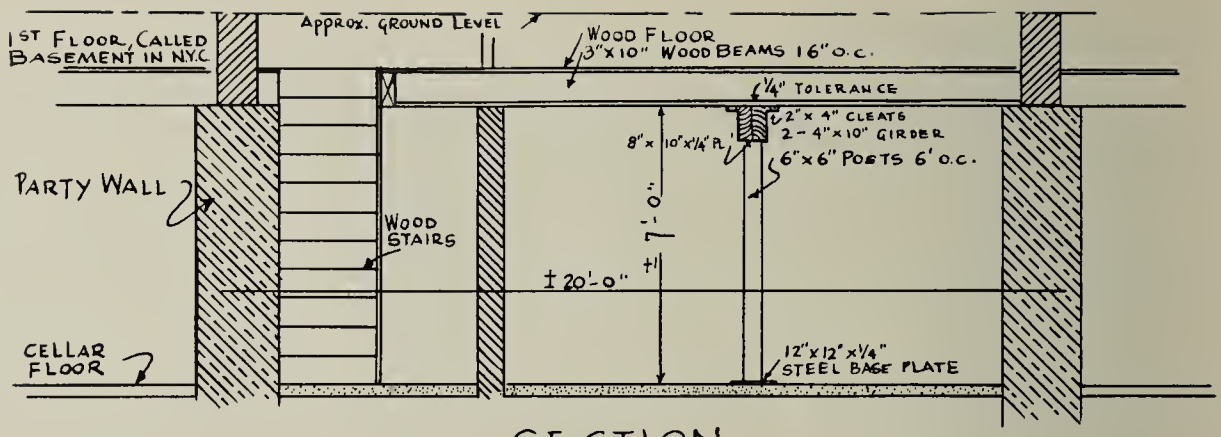
Semi-protective new-law tenement (Type 2)

Variations within the building types were covered by utilizing one of the above shelter types. It will be noticed that the plans utilize only standard building materials, none of which are on a critical materials list.

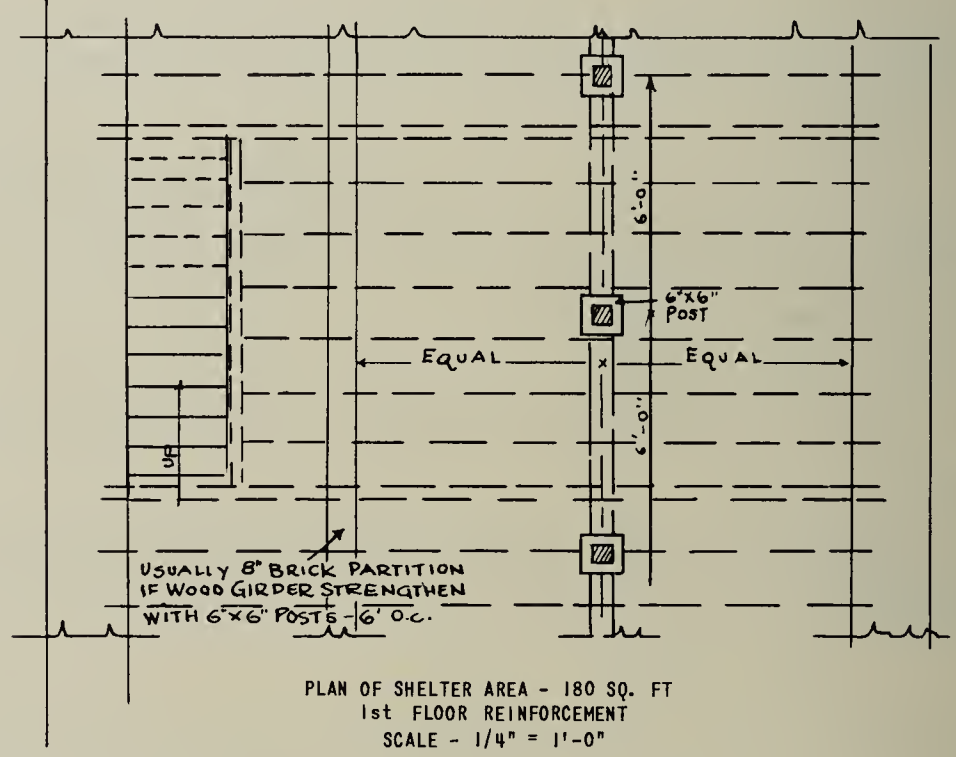
2.9 COSTS.

An estimate of the cost of each shelter was made. The costs of removing glass and other hazards from shelter locations in protective type structures were also estimated.[1] Using these estimates and the summary of building types described in Section 2.3, a total estimate of cost was made. (See Table 2.) Appropriate shelter types were designated for type 5b buildings in which persons were domiciled.

[1]Estimates include labor based on New York pay scales in spring, 1952.



SECTION



PLAN OF SHELTER AREA - 180 SQ. FT
1st FLOOR REINFORCEMENT
SCALE - 1/4" = 1'-0"

CHECK EXIST. 3"X10"
3"X10" @ 16" O.C. SPAN 12'X1/2" = 6'0"
LOADING = 400#/ ' + 10#/ ' = 410#/ '
M = 410 + 550X3 = 2060#
fb = 2460X 12/39.5 = 750#/ "
v = 2060/25X3/2 = 124#/ "

SUPPORTING GIRDER
W = 3.2 K/FT. L = 6'-0"
M = 3.2X36/8 = 14,400'K V = 8,800#
Use f = 1600
v = 170
S.M. = 14,400X12/1600 = 108 2-4"X10" = 109
v = 8800/68.8 = 190#/ "

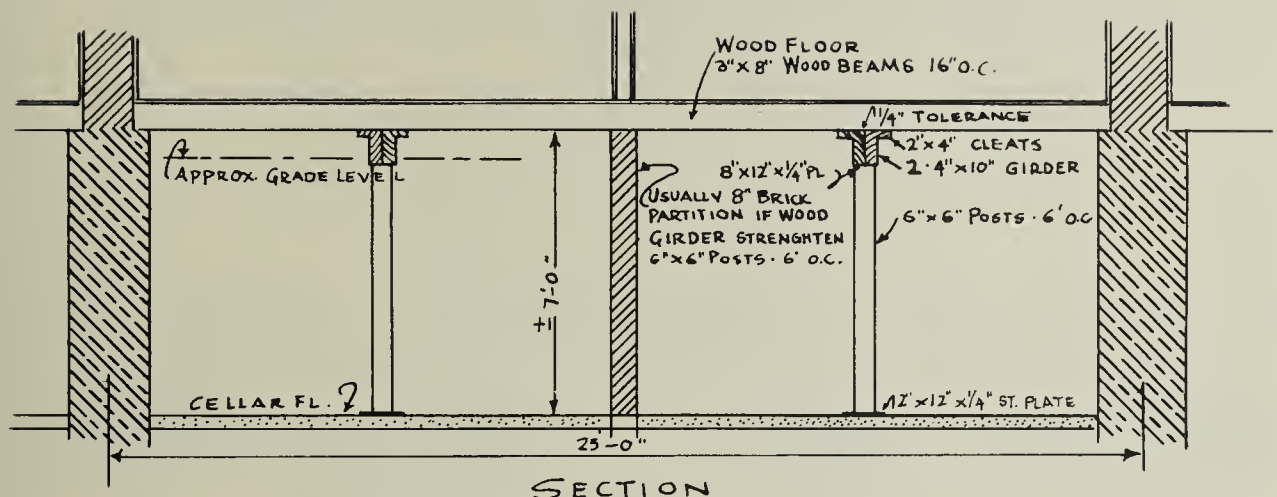
POST
LOAD ON POST = 20K
L = 7'-0" fc = 1000 A = 21 "
6"X6" Post A = 30 "
l/d = 12

APPROX. COST

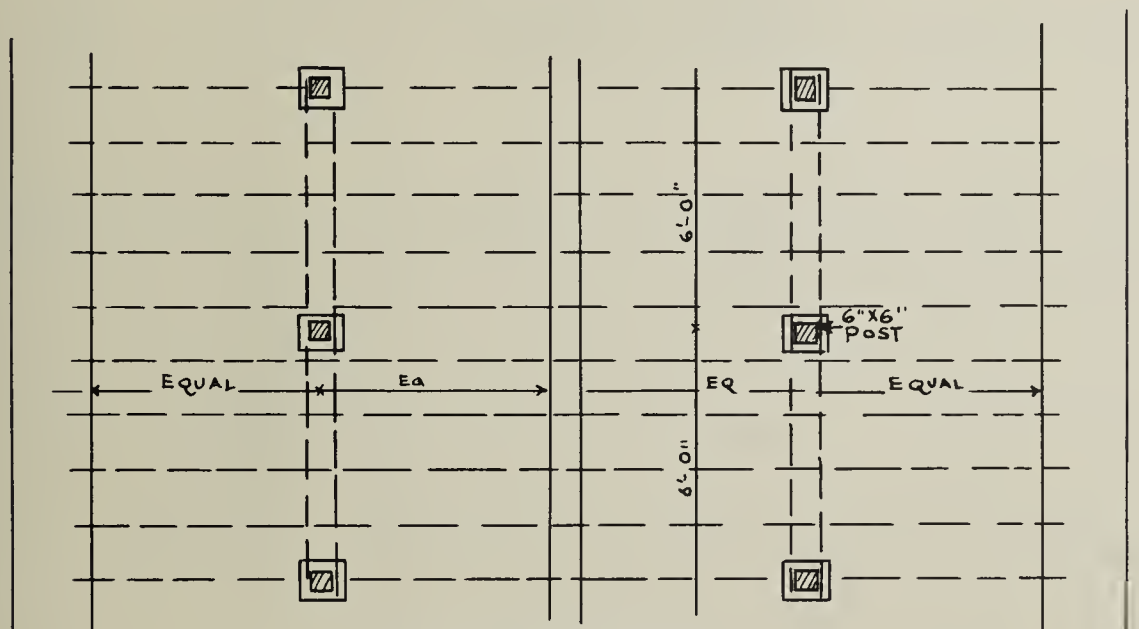
Strengthening Floor	$ 95.00
Miscellaneous Protective Work	15.00
Total	$110.00

CHART I. TYPE I SHELTER AREA

This alteration is intended for typical "brownstone front" residences or converted multiple dwellings, building types 3a and 3b.



SECTION



PLAN OF SHELTER AREA - 275 SQ. FT.
1st FLOOR REINFORCEMENT
SCALE - 1/4" = 1'-0"

CHECK EXIST. 3"X8"
3"X8" @ 16" O.C. SPAN = 6'-0" ±
LOADING = 410#/ '
M = 410X1.33X36/8 = 2460#
V MAX = 410 + 550X3 = 2060
fb = 2460X12/24.6 = 1200#/ "
v = 2060/19.7X3/2 = 157#/ "

SUPPORTING GIRDER
W = 3.2 K/FT. L = 6'-0"
M = 3.2X36/8 = 14,400'# V = 8,800#
Use f = 1600
v = 170
S.M. = 14,400X12/1600 = 108 2-4"X10"S = 109
v = 8,800/68.8 = 190#/ "

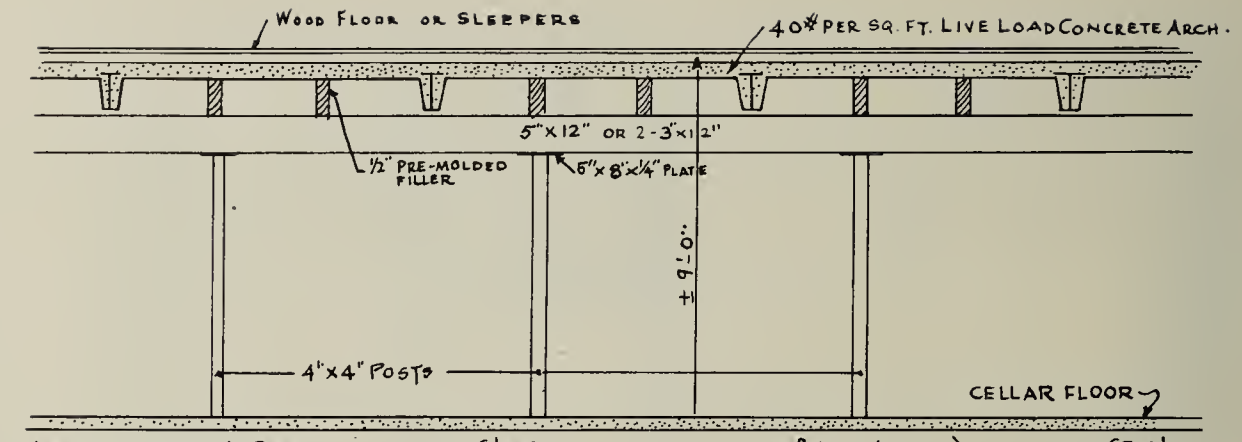
POST
LOAD ON POST = 20K
L = 7'-0" fc = 1000 A = 21 "
6"X6" Post A = 30 "
l/d = 12

APPROX. COST

Strengthening Floors	$190.00
Miscellaneous Protective Work	20.00
TOTAL	$210.00

CHART 2. TYPE 2 SHELTER AREA

This alteration is intended for typical old-law tenements, building type 3c

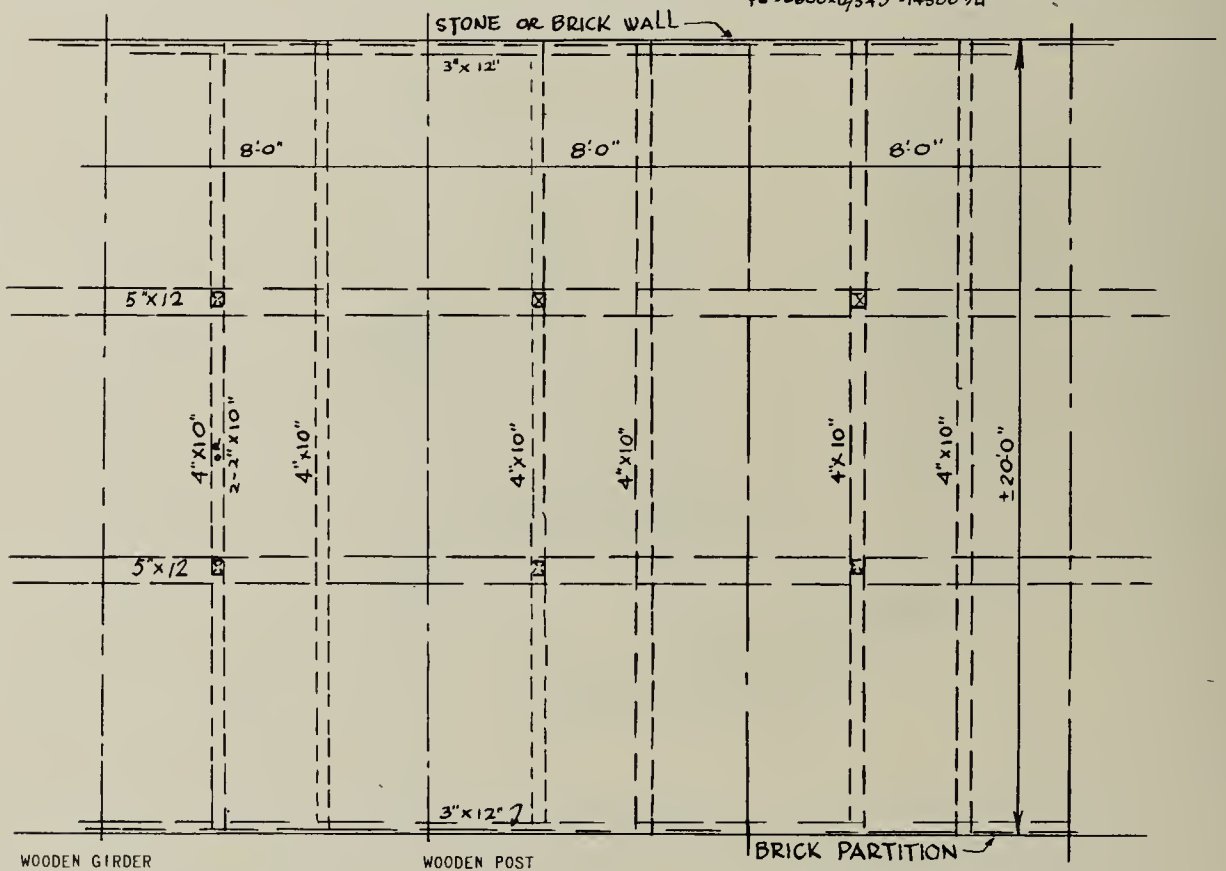


ASSUMED ORIGINAL DESIGN
10" I 26 f_s = 18,000#/□"
WIRE MESH IN 4" CINDER CONC. SLAB
f_s-ULTIMATE = 55,000#/□"
f_s-ALLOWABLE = 27,600#/□"
AS = WL/3C
AS REQ'D = .1082□"

SLAB
LOADING = 445#/□'
CL. SPAN = 2.5'
AS = WL/3 =
= 446X2.5/3X24000
AS = .0465
BASED ON AS = .082 f_s = 15600"/□"

BEAMS (WOODEN)
SPAN = 6'8"
W = 445X26T = 1190#
M = 1190X 6.67/8 = 6600'#
V MAX = 1.15X1190X6.67/2 = 4450#
σ = 200 #/□"
A REQ'D = 4450/200/3/2 = 34□"
f_b = 6600X12/515 = 14500#/□"

STEEL
SPAN = 20'
M = 1.19X20 3/8 = 59.5'K
S.M. AVAIL. 10I 26=
27.1 @ 18,000#/□"
f_s = 26,400 #/□"



WOODEN GIRDER
R = 1190X8 = 9500# SPAN = 8'-0"
M = 9500X2.67X5.33/10 = 13.5'K
V MAX = 9500X2/3 = 6400#
v = 6400/51.75X3/2 = 185#/ "

APPROX. COST

Strengthening Floor	$400.00
Miscellaneous Protective Work	25.00
TOTAL	$425.00

WOODEN POST
P = 9500#
N.L.M.B. 4"X4" POST
L/d = 24 Es = 1,200,000
CS = 1000#/ "
(fc)

PLAN OF SHELTER AREA - 480 SQ. FT.
1st FLOOR REINFORCEMENT
SCALE - 1/4" = 1'-0"

CHART 3. TYPE 3 SHELTER AREA

This alteration is intended for typical semi-protective new-law tenements, building type 2.

TABLE 2

SUMMARY OF SHELTER REQUIREMENTS

Block #	Buildings Type	Buildings No. in Block	Estimated Population	Shelters Needed Type	Shelters Needed Number	Total Cost	Average Cost per Shelter	Average Cost per Person	Remarks
1	3a	40	635	1	40	$4,400		$ 6.93	
1	3b	6	37	1-A	6	450		12.86	
Totals		46	672		46	4,850	$105.43	7.22	
2	3a	32	350	1	32	3,520		10.06	
2	3b	12	72	1-A	12	900		12.50	
2	3c	10	75	1	10	1,100		14.67	
2	1	2	225	—	—	—	—	—	Existing Shelters
Totals		56	722		54	5,520	102.22	7.65	
3	3a	13	104	1	13	1,430		13.75	
3	3b	33	130	1-A	33	2,475		19.04	
3	3c	17	120	1	17	1,870		15.58	
3	2	1	128	3	2	850		6.64	
Totals		64	482		65	6,625	101.92	13.74	
4	2	8	342	3	8	3,400		9.94	
4	3a	9	138	1	9	990		7.17	
4	3b	13	60	1-A	13	975		16.25	
4	3c	10	150	1	10	1,100		7.33	
Totals		40	690		40	6,465	161.62	9.37	
5	3a	6	108	1	6	660		6.11	
5	3c	4	100	1	4	440		4.40	
5	5a	1*	105	—	—	—	—	—	Existing Shelter — in
5	5b	1	115	2	2	420		3.65	adjacent hospital
Totals		11	323		12	1,520	126.66	4.71	
6	3a	8	303	1	11	1,210		3.99	
6	2	3	126	3	3	1,275		10.12	
Totals		11	429		14	2,485	177.50	5.79	
7	1	1	1,504**	—	—	—	—	—	Existing Shelter
8	2	30	2,271	3	30	12,750	425.00	5.61	

* Population for Hospital and Nurses' Home in this block are not included in any of the totals.
** This population not included in 1950 census figures.

TABLE 2 (continued)

Block #	Buildings: Type	Buildings: No. in Block	Estimated Population	Shelters Needed: Type	Shelters Needed: Number	Shelters Needed: Total Cost	Average Cost per Shelter	Average Cost per Person	Remarks
9	1	1	523	—	—	—	—	—	Existing Shelter
9	2	1	57	3	1	425		7.46	
9	3a	3	37	1	3	330		8.92	
9	3b	16	80	1-A	16	1,200		15.00	
9	3c	12	206	1	12	1,320		6.41	
Totals		33	903		32	3,275	102.34	3.63	
10	3a	39	664	1	39	4,290		6.46	
10	3b	6	30	1-A	6	450		15.00	
10	3c	7	120	1	7	770		6.42	
Totals		52	814		52	5,510	105.96	6.77	
11	1	2	275	—	—	—	—	—	Existing Shelter
11	3a	12	416	1	14	1,540		3.70	
11	3c	15	315	1	15	1,650		5.24	
11	5b	3	78	1	3	330		4.24	
Totals		32	1,084		32	3,520	110.00	3.25	
12	2	2	201	3	3	1,275		6.34	
12	3a	2	72	1	3	330		4.58	
12	3c	21	463	1	21	2,310		4.99	
12	5b	1	235	2	4	840		3.73	
Totals		26	971		31	4,755	153.39	4.90	
13	1	1	90	—	—	—	—	—	Existing Shelter
13	3a	23	130	1	23	2,530		19.46	
13	3b	6	35	1-A	6	450		12.86	
13	3c	16	180	1	16	1,760		9.78	
13	5a	2	250	—	—	—	—	—	Existing Shelter
13	5b	7	58	1-A	7	525		9.23	
Totals		55	743		52	5,265	101.25	7.09	
14	Approach to bridge		—	—	—	—	—	—	
15	3a	18	700	1	24	2,640		3.77	
15	3c	18	379	1	18	1,980		5.22	
Totals		36	1,079		42	4,620	110.00	4.28	

Block #	Type	No. in Block	Estimated Population	Type	Number	Total Cost	Average Cost per Shelter	Average Cost per Person	Remarks
16	2	1	100	3	2	850		8.50	
16	3a	18	710	1	24	2,640		3.72	
16	3c	5	120	—	—	—	—	—	Existing Shelter
16	3c	8	256	1	9	990		3.87	
16	5b	1	10	—	—	—	—	—	To be sheltered in
Totals		33	1,196		35	4,480	128.00	3.75	School #16
17	2	2	337	—	—	—	—	—	Existing Shelter
17	3a	11	120	1	11	1,210		10.08	
17	3c	9	173	1	9	990		5.72	
17	5b	5	28	1	5	550		19.64	
Totals		27	658		25	2,750	110.00	4.18	
18	3a	1	40	1	1	110		2.75	
18	3c	4	111	1	4	440		3.96	
18	5b	1	30	1	1	110		3.66	
Totals		6	181		6	660	110.00	3.65	
19	2	4	320	3	4	1,700		5.31	
19	3a	5	205	1	7	770		3.76	
19	3c	12	350	1	12	1,320		3.77	
Totals		21	875		23	3,790	164.78	4.33	
20	2	1	134	3	2	850		6.34	
20	3a	22	450	1	22	2,420		5.38	
20	3b	2	15	1-A	2	150		10.00	
20	3c	20	850	1	29	3,190		3.25	
20	5b	1	24	1	1	110		4.60	
Totals		46	1,473		56	6,720	120.00	4.56	
21	2	11	650	3	11	4,675		7.19	
21	3a	2	264	1	9	990		3.75	
21	3c	7	280	2	7	1,470		5.25	
Totals		20	1,194		27	7,135	264.26	5.98	
22	High School and playground				—	—	—	—	Daytime population only

TABLE 2 (continued)

Block #	Buildings: Type	Buildings: No. in Block	Estimated Population	Shelters Needed: Type	Shelters Needed: Number	Shelters Needed: Total Cost	Average Cost per Shelter	Average Cost per Person	Remarks
23	1	4	525	—	—	—	—	—	Existing Shelter
23	3a	22	400	1	22	2,420		6.05	
23	3b	9	60	1-A	9	675		11.25	
23	3c	9	310	2	9	1,890		6.10	
Totals		44	1,295		40	4,985	124.62	3.85	
24	3a	35	1,118	1	37	4,070		3.64	
24	3c	19	400	1	19	2,090		5.23	
Totals		54	1,518		56	6,160	110.00	4.06	
25	2	1	113	3	2	850		7.52	
25	3a	18	632	1	21	2,310		3.77	
25	3c	19	570	1	19	2,090		3.67	
25	5a	1	20	—	—	—	—	—	Existing Shelter
Totals		39	1,335		42	5,250	125.00	3.93	
26	1	2	190	—	—	—	—	—	Existing Shelter
26	2	2	263	3	4	1,700		6.46	
26	3a	18	757	1	26	2,860		3.78	
26	3c	6	120	1	6	660		5.50	
Totals		28	1,330		36	5,220	145.00	3.92	
27	Approach to Bridge			—	—	—	—	—	No Popuation
28	—	—	—	—	—	—	—	—	Industrial, daytime population only
29	3c	3	106	2	3	630	210.00	5.94	
30	1	1	1,210*	—	—	—	—	—	Existing Shelter
30	3a	2	90	1	3	330		3.67	
30	3c	8	204	1	8	880		4.31	
Totals		11	1,504		11	1,210	110.00	.80	

* This population not included in 1950 census figures.

Block #	Type	No. in Block	Estimated Population	Type Number		Total Cost	Average Cost per Shelter	Average Cost per Person	Remarks
31	3a	11	415	1	14	1,540		3.71	
31	3c	8	135	1	8	880		6.52	
Totals		19	550		22	2,420	110.00	4.40	
32	2	6	2,078	3	26	11,050	425.00	5.32	
33	2	6	706	3	9	3,825		5.42	
33	3a	9	420	1	14	1,540		3.67	
33	3c	12	240	1	12	1,320		5.50	
Totals		27	1,366		35	6,685	191.00	4.89	
34	2	11	1,277	3	16	6,800	425.00	5.32	
35	5a	1	36	—	—	—	—	—	Existing Shelter *
36	2	6	379	3	6	2,550		6.73	
36	3a	4	384	2	6	1,260		3.28	
36	5b	3	190	—	—	—	—	—	**
Totals		13	953		12	3,810	317.50	4.00	
37	2	6	462	3	6	2,550		5.52	
37	3a	9	208	1	9	990		4.76	
37	3c	13	640	1	13	1,430		2.23	
Totals		28	1,310		28	4,970	177.50	3.79	
38	2	3	380	3	5	2,125		5.59	
38	3a	12	480	1	16	1,760		3.67	
38	3c	21	474	1	21	2,310		4.87	
Totals		36	1,334		42	6,195	147.50	4.64	
39	3a	11	100	1	11	1,210		12.10	
39	3b	1	6	1-A	1	75		12.50	
39	3c	26	1,074	2	26	5,460		5.08	
Totals		38	1,180		38	6,745	177.50	5.72	

* Hospital, neither population nor buildings included in any totals.

** Convent population (40) sheltered in Memorial Hospital, Block 35; Temporary student housing population (190) sheltered in New York Hospital, Block 45.

TABLE 2 (continued)

Block #	Buildings: Type	Buildings: No. in Block	Estimated Population	Shelters Needed: Type	Shelters Needed: Number	Shelters Needed: Total Cost	Average Cost per Shelter	Average Cost per Person	Remarks
40	—	—	—	—	—	—	—	—	Industrial, daytime population only +
41	—	—	—	—	—	—	—	—	Vacant, no population
42	—	—	—	—	—	—	—	—	Industrial, daytime population only +
43	—	—	—	—	—	—	—	—	Industrial, daytime population only +
44	5a	1	57	—	—	—	—	—	Existing Shelter *
45	5a	1	190	—	—	—	—	—	Existing Shelter *
46	5a	1	577	—	—	—	—	—	Existing Shelter *
47	—	—	—	—	—	—	—	—	Industrial, daytime population only +
Grand Total		1,003	35,400		1,081	$164,825	$152.47	$4.66	

* Hospital, neither population nor buildings included in any totals.
\+ Not included in Grand Total.

Table 2 indicates that adequate private shelters could be provided in each building at an average cost of $4.66 per person for the residents of the selected area.

The use of public funds for construction of shelters in private homes, apartments, etc. was discussed. It was considered very probable that in the event of a continuing national emergency, state legislation will be enacted which requires owners to provide shelters in accordance with predetermined standards, with financial assistance from the State or Federal Government. This would be similar to the World War II legislation in New York requiring owners to provide sand buckets, water buckets, and implements for fighting fire.

2.10 AVAILABILITY OF INFORMATION.

The maps originally adopted for use by the study group had been prepared for another project and purpose and were special in the sense that such maps would not be readily available in other cities or even in other areas of New York City. This defect in the study was noted in the early stages. Accordingly, an investigation was made of other possible sources of information. It was suggested that photomosaics might be readily available for the target areas of the United States through the activities of several Federal agencies, particularly the Department of Defense. (In connection with another part of the Project East River study, an attempt to obtain photomosaics for another target area was unsuccessful.) No effort was made to obtain such photographs from commercial sources.

Among the various possibilities investigated, Sanborn maps seem to be most promising. They are available for practically all possible target areas, and are maintained on a current basis. Sanborn maps of a segment of the selected area were examined and found to include even more pertinent information than the special maps insofar as the purposes of the shelter study were concerned.

2.11 CONCLUSIONS.

Based on the studies made, the following conclusions were reached:

1. In any target area, trained and experienced local personnel (that is, architects, engineers and city building inspectors), utilizing Sanborn maps, census figures, and other information readily available in every locality, could make a rapid and satisfactory appraisal of shelter requirements and prepare practical shelter plans, including estimates of

cost, for the domiciled population. An extension to daytime conditions would require daytime census figures. It is understood that the Federal Civil Defense Administration, through the Bureau of the Census, is developing these daytime figures.

2. The provision of an individual shelter for each building would be much more practical than building public shelters for the people living in the selected area because (a) greater convenience would be provided for the population and confusion as to the location of the nearest shelter would be eliminated; (b) less warning time before an attack would be required for people to reach shelter; (c) the cost would be a great deal less; and (d) psychologically, the existence of a shelter in each building would give the population a greater sense of security and reduce any tendency toward panic.

3. PHYSICAL DAMAGE ESTIMATES.

The physical consequences of an A-bomb burst are (a) blast damage, including both flying missiles and the collapse of structures; (b) fire damage, including both the primary fires started by the intense heat of the A-bomb burst and the secondary fires started by other disruptions such as upset coal stoves; and (c) residual radioactive contamination. Except for the possible fogging of photographic films and similar types of damage, the radioactive contamination is not particularly harmful to inanimate objects. As contamination may be a very real hazard to living things, it was included in the study and will be discussed in this section. Blast and fire are the two most spectacular consequences of a bomb burst. Of these, the blast is the more sudden and the more difficult to combat.

3.1 ASSUMED CONDITIONS.

In order to estimate the destruction which would result from an atomic explosion over the selected area it was first necessary to assume certain conditions, such as size of bomb, height of burst above ground and distance from ground zero (GZ). It was decided to consider the effects of both a 1X bomb at a height of 2000 feet above the ground and an 8X bomb at a height of 4000 feet. It was also decided that studies would be made on the basis of (a) GZ directly over the target, (b) GZ one-half mile away (c) GZ one and one-half miles away and (d) GZ four miles distant. To reduce variables further, it was assumed that the entire selected area would be at these distances from ground zero. (A fifth condition, a bomb drop in the East River adjacent to the selected area, is reported in Section 3.8.) Other variables, such as direction of blast, were considered in only certain cases.

3.2 INFORMATION AVAILABLE

As indicated in Section 1.3, the principal sources of unclassified information were the reports of the Physical Damage Division of the United States Strategic Bombing Survey on the A-bomb damage at Hiroshima and Nagasaki and "The Effects of Atomic Weapons." The participants also drew upon their personal knowledge and experience. It can be said, therefore, that the available information on A-bomb effects was limited and was insufficient to permit the preparation of any more definite report than a broad estimate of the damage that would result under the bomb-burst conditions assumed.

3.3 BOMB SIZE.

The damage from an 8X bomb as compared to that from the 1X bomb for which we presumably have some data from Japan has been obtained by scaling upward in proportion to the increased overpressures. These overpressures were determined by using the pressures and scaling laws given in "The Effects of Atomic Weapons" corrected for the actual distance from the center of detonation.

3.4 STEEL AND CONCRETE FRAME STRUCTURES—(Building Types 1 and 5a).

These structures are more than six stories high with either reinforced concrete or structural steel frames, as previously described in section 2.3. The frame is designed to withstand a wind pressure of 30 psf. Roofs are designed for a live load of 40 psf and floors for 50-psf live load.

When these structures are subjected to blast, it is anticipated that windows will be broken and interior partitions blown down so that pressures on floors and walls will be more or less equalized. The stiffness of the floors and the closure walls will tend to retard the horizontal deflection of the building and to that extent reduce damage to the structural frame. Except at locations close to GZ, the danger of collapse of the buildings will be eliminated. It must be expected that some closure walls will be blown out or in, depending on the direction of the blast.

3.5 WALL-BEARING STRUCTURES—(Building Types 2, 3, and 5b).

Most of the buildings in the area are continuous structures from one end of the block to the other end. Even though they are brick wall-bearing they will gain some strength from this continuous construction. Nothing was found in the reports of the Japanese explosions which would

parallel this type of construction. It is considered that this row construction tends toward natural weakness in brick wall-bearing buildings if the blast direction is from front to rear or vice versa. On the contrary, if it is from one end of a row of buildings to the other end, the first and last buildings would be inherently weak and the buildings in between would gain some strength because of the continuity of the construction.

3.6 ESTIMATES OF BLAST DAMAGE.

3.6.1 1X Bomb—Ground zero over center of area at height of 2000 feet.

3.6.1.1 Fireproof structures over six stories high with structural steel frames, concrete floors and roofs, eight-inch-thick brick curtain walls supported at each floor, and partitions of three-inch gypsum block. (These would include building types 1 and 5a in Section 2.3)

Windows, curtain walls and partitions would be blown in or out in direction of blast, roof and many floors buckled, structural frame badly warped and twisted.

3.6.1.2 Brick wall-bearing structures with wood floors and roof, stud partitions plastered, ceilings plastered except in new-law tenements where first floor is cinder concrete. (These would include building types 2, 3a, 3b, 3c and 5b in Section 2.3.)

Roofs and several floors of all buildings would be collapsed, partitions and windows blown in direction of blast, front walls in buildings facing blast blown in, rear walls blown out, considerable collapse of party walls. In rows of buildings parallel to the direction of blast there might be slightly less damage but it would still mean practical destruction of the buildings.

3.6.2 8X Bomb—Ground zero over center of area at height of 4000 feet.

Damage to all buildings would be the same as above but to a greater extent. Probably all buildings would be completely wrecked. Steel frame structures probably would collapse.

3.6.3 1X Bomb—Ground zero one-half mile from edge of area at height of 2000 feet.

3.6.3.1 *Buildings as in Section 3.6.1.1.*

All windows would be blown in and many interior partitions destroyed. Exterior walls in direct line of blast would be blown in or out

by "side on" pressure. Roof and some floors would collapse and buckle; structural frames would be twisted and warped. There would be some failures of brick curtain walls parallel to the direction of blast. These probably would fall out from the building.

3.6.3.2 Buildings as in Section 3.6.1.2.

Buildings facing the direction of the blast would have all windows and interior partitions blown in or out, front and rear walls collapsed, the roofs and two or three floors below severely buckled, and many party walls collapsed. Rows of these buildings parallel to the blast would have all windows blown in, roofs and parapet walls collapsed, some floors below the roof buckled. The first and last building of the row would collapse due to the destruction of the end-bearing walls.

3.6.4 8X Bomb—Ground zero one-half mile from edge of area at height of 4000 feet.

Damage to all buildings would be similar to that for a 1X bomb but more extensive. Row houses would probably collapse, regardless of blast direction. Steel frame structures might collapse.

3.6.5 1X Bomb—Ground zero one and one-half miles from edge of area at height of 2000 feet.

3.6.5.1 *Buildings as in Section 3.6.1.1.*

Windows would be blown in or out in the direction of blast and broken completely when at right angles to blast. Interior partitions would be destroyed. Many eight-inch brick curtain walls would be blown in or out, the extent of damage depending on exposure to direct blast and limited insofar as floors and columns lend support. The roof would be severely buckled; many floors would be buckled or cracked, and the structural frames would be twisted and warped.

3.6.5.2 *Buildings as in Section 3.6.1.2.*

Windows would be blown in or out, many interior partitions destroyed, plaster destroyed throughout buildings, and most of the roofs and some of the lower floors collapsed. Many buildings facing the blast would have front and rear walls blown in or out, party walls in other than row houses would collapse. End buildings of rows of houses parallel to the blast would collapse. Probably 25 per cent of the buildings in the area would be destroyed.

3.6.6 8X Bomb—Ground zero one and one-half miles from edge of area at height of 4000 feet.

3.6.6.1 ***Buildings as in Section 3.6.1.1.***

Damage would be same as in Section 3.6.5.1 but 70 per cent to 80 per cent more extensive.

3.6.6.2. ***Buildings as in Section 3.6.1.2.***

Probably 60 per cent to 70 per cent of these buildings would be destroyed. All roofs would collapse as well as one or two of the upper floors. These would in turn cause failure of lower floors down to the area reinforced for shelter.

3;6.7 1X Bomb—Ground zero four miles from edge of the area at height of 2000 feet.

3.6.7.1. Buildings as in Section 3.6.1.1.

Minor glass breakage and plaster damage would occur. Roofing would be destroyed but not burned. There would be no damage to curtain walls or structure.

3.6.7.2. ***Buildings as in Section 3.6.1.2.***

Windows would be broken but not blown out. Very few if any buildings would be partially destroyed, and they would be isolated unshielded structures facing the blast. Roofing would be destroyed but not burned.

3.6.8 8X Bomb—Ground zero four miles from edge of area at height of 4000 feet.

The damage indicated above for 1X bomb at four miles will be about doubled in all buildings.

3.7 ESTIMATES OF FIRE DAMAGE.

The fires resulting from an A-bomb burst are of two types. The primary fires are ignited by the intense heat of the burst. Secondary fires are ignited by such consequences of the burst as up-set stoves and shorted electrical wiring. Broken gas pipes in damaged buildings spread the fires to combustible debris.

3.7.1 Primary Fires.

Primary fires may be found in a large area including the central area of complete destruction and heavy damage. In the area of complete destruction, primary fires are not considered to be much of a hazard. All

structures will have been wrecked by the blast, and all applicable experience indicates that the piles of debris and rubble would smoke and smoulder rather than burst into lively flames. Outside the area of complete destruction, primary fires may constitute a major hazard. The extent of such fires will depend on many factors in addition to the size of the bomb, for example, the meteorological conditions preceding, at the instant, and following the bomb burst; and the physical nature and condition of the surfaces exposed to the bomb flash. Unlike most ordinary fires, primary fires start simultaneously throughout an entire side of a building. For example, if one of the tenement houses in the selected area were close to an A-bomb burst, the interior furnishing in every room on the side of the building exposed to the bomb flash might burst into flames simultaneously. Consequently, the entire building would be on fire in a matter of minutes. As this condition might prevail in building after building, block after block, and street after street, the over-all fire situation would be quite different than the normal peacetime fire.

Generally speaking, in peacetime the professional fire fighters surround a fire to contain it and prevent its spread to neighboring buildings. With this accomplished, the fire fighters next proceed to bring the fire under control. However, the estimated condition of primary fires resulting from an A-bomb more nearly resembles a forest fire than anything else in United States experience. It will tax the professional fire fighters, augmented by forces from nearby communities, to control the primary fires merely to the extent of containing them in the already damaged areas. If conditions are such that the primary fires develop into a conflagration or a firestorm, there is little that the fire fighters can do. The best measures are preventive measures: to reduce the vulnerability of the area (see Parts II B and V of the report of PROJECT EAST RIVER); and to reduce the possibility of the ignition of primary fires through a reduction of the flash intensity falling on exposed surfaces (see Part III, Appendix A) and by covering inflammable surfaces, for example, closing metal blinds at windows.

3.7.2. Secondary Fires.

A review of the secondary fire problem led to the following conclusions:

(a) Secondary fires usually would start as small, point sources;
(b) These point sources would be relatively well dispersed;
(c) The contributions of broken gas pipes, shorted electrical wiring, and damaged furnaces have been given too much emphasis; the total number of room or space heaters, usually kerosene stoves, has been

estimated to be no more than 2000 in the entire area, and this hazard would be further reduced if the flames were turned down on the YELLOW alert;

(d) Advance warning to the public to permit a few simple precautionary measures might result in as much as a 50 per cent reduction in secondary fires from the above causes;

(e) Prompt action by the public (nonprofessional firefighting force and auxiliaries) can cope with many small secondary fires in *the early stages;*

(f) The area of possible secondary fires is much greater than the area of probable primary fires; hence, if the secondaries get out of control the potential fire-storm hazard would be much greater.

The precautionary measures visualized in (d) include the putting out of open flames, prompt disposal of large amounts of highly inflammable liquids such as some cleaning fluids and turning off nonessential electrical circuits. The prompt action called for in (e) depends upon a means of communication between the civil defense headquarters and the public in their shelters in order that the public may be advised at the earliest possible moment when to leave shelter areas and start fighting fires. It also presupposes that the public has been educated to the point that elementary fire fighting equipment is kept always ready and at hand.

3.7.3. The Relative Threat of Primary and Secondary Fires.

We believe that both primary and secondary fires constitute a threat. There are great uncertainties attending both types. The incidence of primary fires has been observed at every A-bomb burst (excluding such special cases as the underwater burst at Bikini.) Nevertheless, the information available to civil defense planners and fire fighting personnel is meager. Despite the millions of dollars that have been expended on A-bomb tests, this vital question for civil defense cannot be answered. It is possible that sufficient experimental observations have been made so that the consolidated data give a reasonably certain picture of the primary fire situation. If this be the case, the information has not been released to the Federal Civil Defense Administration. It is believed that evidence to date indicates that primary fires are frequent, rather than rare, phenomena. Contrary to our understanding of the fire doctrine now accepted in the United States, the study group concludes that primary fires are as great or a greater hazard than secondary fires. The evidence available to us indicates that the incidence of secondary fires has been over emphasized.

It is important to note that primary fires call for organized preventive measures and professional fire fighters. Secondary fires, on the

other hand, may be countered by relatively simple preventive measures and, if action is prompt, by nonprofessional fire fighters. In conclusion, we recall that a basic premise of PROJECT EAST RIVER is that the civil defense task must be divided into distinct, manageable parts and that responsibility for these be clearly assigned. We note that the professional fire fighters will be taxed by the large fires, whether primary or secondary, particularly in view of the difficulty of moving their equipment. If they must cope with a large number of small fires as well, their task becomes unmanageable. Hence, it is most important that civil defense organize the public to handle the major part of the secondary fire problem. This problem is manageable on the part of the nonprofessional fighters provided that "good housekeeping" and fire preventive measures are continuously followed; that adequate warning of an impending raid is given to permit a few simple, last-minute preventive measures; that the public is trained or conditioned to combat small fires; and that advice is given by the civil defense headquarters as soon as it is practical for the combat of secondary fires to commence.

3.7.4 Fire or Burn Casualties

As the fire casualties may vary between zero and a high percentage of the total population, depending on many independent or slightly related factors, and since no detailed study was made of the area, no attempt will be made by the study group to estimate the probable number of fire casualties.

3.8.—CONTAMINATION.

The principal hazard of contamination would be in the event of a burst in the shallow water of the East River. A study was made on the assumption that a bomb burst in the west channel of the East River at the Queensborough Bridge. Measured from this ground zero, the intersections of 59th Street and FDR Drive, 59th Street and Third Ave., 72nd Street and FDR Drive, and 72nd Street and Third Ave. are at distances, respectively, of 1500, 6800, 7200, and 9600 feet. For this case it is necessary to interpolate across the selected area, for it would obviously be in error to assume that the conditions at 1500 feet pertain throughout the area.

It was assumed that a five-mph wind was blowing from the ground zero across the area. Estimates of blast damage and of contamination were based on data in "The Effects of Atomic Weapons." In a study of the effectiveness of shielding, it was recognized that the hardness or penetrating power of the gamma rays from the residual contamination was 0.7 MEV as compared to an average hardness of 3.0 MEV, with some as hard as 4.5 MEV, for the initial radiation. As a consequence, only

half as much material will give the same shielding against the contamination radiation as a full thickness of shielding gives against the initial radiation.

A study has been made of the exposures received by persons "in the open" as compared to those in 12-inch concrete shelters. For all, it was assumed that an order to evacuate the area is given by the civil defense authorities at a certain time after the burst, indicated by the symbol "te". This "walkout" introduces additional exposure. Those who receive less than a total of 100 r units are not considered to be casualties for the purposes of this study. ("r" is the unit of radiation dosage, the roentgen.)

The actual contamination from a shallow water burst may cover many square miles in a complicated, swirled pattern resulting from differing wind speeds and directions at various altitudes and from differing falling rates depending on particle size. For the immediate vicinity of the burst, however, we may assume a simpler pattern without great error. Table 3 reflects data calculated for distances of one, two, three, four, and five thousand feet. The second column of Table 3 gives assumed contaminations (Figure 8.101 of "The Effects of Atomic Weapons") in r units per hour at one hour after the burst. The values given are not precise; however, they are of the right order of magnitude and are sufficiently accurate for the present study. As the selected area is small, we may assume that loci of constant contamination are arcs of circles. The third column gives the time symbol, t_c, in minutes for the contamination to reach the respective ranges, assuming a five-mph wind blowing from the zero point across the selected area. The next five columns headed by various assumed evacuation times, t_e, each have three subdivisions; the exposure received in the open in the interval (t_e—t_c), the exposure received in a 12-inch concrete equivalent shelter during the same interval, and the exposure received in walking out of the area. This last exposure is assumed to be equal to that of a 15-minute walk in an area of constant contamination equal to that of the starting point. These entries are all computed on the basis of our assumed contamination and the assumed t_c and t_e's and with the use of Figure 8.17 contained in "The Effects of Atomic Weapons."

TABLE 3—ASSUMED CONTAMINATION AND CONSEQUENT EXPOSURES BASED ON 0.7 MEV GAMMA RAYS

R Feet	Contamination. r/hr at 1 hour	t_c* Minutes	Exposure (r-units) for t_e** = 30 minutes			Exposure (r-units) for t_e = 1 hour		
			Open	Shelter	Walk-out	Open	Shelter	Walk-out
1000	1500	2.4	5700	114	600	6750	135	300
2000	500	4.8	1250	25	200	1600	32	100
3000	300	7.1	600	12	120	810	16	60
4000	150	9.5	240	5	60	348	7	30
5000	75	11.9	90	2	30	140	3	15

R Feet	Exposure (r-units) for t_e = 2 hours			Exposure (r-units) for t_e = 4 hours			Exposure (r-units) for t_e = 8 hours		
	Open	Shelter	Walk-out	Open	Shelter	Walk-out	Open	Shelter	Walk-out
1000	7800	156	150	8550	170	75	9450	189	—
2000	1950	38	50	2200	44	25	2500	50	—
3000	1000	20	30	1170	23	15	1350	27	—
4000	450	9	15	525	10	8	615	12	—
5000	195	4	8	232	5	4	278	6	—

*t_c is the time interval, measured from the instant of bomb burst, for the contamination to cover the distance R.

**t_e is the time, measured from the instant of the bomb burst, at which directions are given for evacuation.

In Table 4 these results are collected to give the total exposure (in r units) received up to time t_e plus that received in evacuating area.

TABLE 4—TOTAL EXPOSURE (IN R-UNITS)

R feet	t_e 30 minutes		t_e 1 hour		t_e 2 hours		t_e 4 hours		t_e 8 hours	
	*o-w	s-w	o-w	s-w	o-w	s-w	o-w	s-w	o	s
1000	6300	714	7050	435	7950	306	8625	245	9450	189
2000	1450	225	1700	132	2000	88	2225	69	2500	50
3000	720	132	870	76	1030	50	1185	38	1350	27
4000	300	65	378	37	465	24	533	18	615	12
5000	120	32	155	18	203	12	236	9	278	6

Note: (a) After eight hours, the exposure obtained while walking out of the area is negligible compared to the exposure already received.
(b) At 1000 feet, people in 12-inch shelters will always receive more than the 100-r exposure, taken as the casualty limit for this study; however, the 189-r, 245-r, and even 306-r exposures need not be fatal in all cases.
(c) For people in the "open", the situation gets progressively worse for all evacuation times, t_e. Hence, the first instinct to run out of the area immediately is probably the best, unless a good shelter is near and means of decontaminating body and clothing are available.
(d) For people partially sheltered, the situation may grow worse or improve with t_e, depending on the amount of shelter. For a shelter equivalent to seven inches of concrete, (Table 7.37, page 233 of the reference) which reduces exposures to about one-tenth of the "open" exposure, the total exposure (while awaiting the evacuation instructions plus the walk-out) is approximately constant and independent of t_e. For the five ranges under examination here, this "constant" exposure is roughly one-tenth of the open exposure in the $t_e = 8$ hours column. Thus, a seven- to eight-inch concrete shelter takes on a new significance.

*o=open; w=walk-out; s=shelter

The question is raised whether or not it would be desirable to rush into a shelter after the explosion even if there is not an advance warning. If one knew in which direction to flee to escape the area before it becomes contaminated, this would be the best action. Without this information, it next seems best to seek a good shelter immediately, before personal clothing and skin become contaminated.

To determine potential casualties[1] (defined as all receiving an exposure greater than 100 r units), divide the selected area into concentric 1000-foot rings, centered about the assumed zero point of the under-water burst.

(a) All within the 1000-foot line are potential casualties. (A few more inches of concrete in addition to the 12 inches assumed would "save" those in shelters.)

(b) In the 1000-2000 ring, all would be potential casualties except those having at least ten inches of concrete plus proper evacuation instructions.

(c) In the 2000-3000 ring, potential casualties are those having less than eight inches of concrete and/or lacking proper instructions.

(d) In the 3000-4000 ring, potential casualties are those having less than six inches of concrete and/or lacking proper instructions.

The above discussion has been on the basis of a nominal bomb. If an 8X bomb were exploded under water in the western channel of the East River, all of the above contamination and exposure figures would be multiplied by a factor of eight. With the meteorological and all other factors as assumed above, this means that everyone in the selected area would be a potential radiation casualty if they stayed in the area. Of course, six more inches of concrete for everyone would reduce the problem to the 1X case.

The best action in any particular situation requires an analysis of a rather complex problem. For example, if the wind velocity is less than five mph., people in the outer rings could probably get out of the area to be contaminated before the contamination arrives. Furthermore, the smaller the wind velocity, the greater the concentration will be near the bomb and the lesser the concentration will be further away. On the other hand, if the wind velocity is higher, the possible time for action before contamination arrives is smaller and also the contamination will be more uniform over a larger area. This latter factor implies that one would have to go further to get out of the contaminated area.

This study further demonstrates:

(a) The need for an expert analysis of the prevailing meteorological conditions (during the YELLOW alert period, if possible).

[1]Many of the casualties might be very mild and virtually negligible from the medical standpoint, particularly as we are here considering 0.7—MEV. radiation.

(b) The importance of prompt determination of the *location* and *nature* of the A-bomb burst.
(c) The need for prompt issuance of instructions to residents in the involved area, assisted by a prior educational program on proper procedures. (Radio seems to offer the best means of communication.)

4. CASUALTY ESTIMATES.

The purpose of this study is to indicate how the number of casualties in the selected area from various hazards of an atom bomb attack will be reduced if appropriate shelters are made available and if sufficient warning is provided so that individuals will be able to reach these shelters. It is assumed that appropriate shelters of the type proposed in the shelter survey will be available. It should be noted that these shelters do not provide absolute protection under all conditions as it would be practically impossible to provide absolute protection against a very large bomb that burst directly over the area.

The general procedure followed has been to compare, for each type of hazard, the estimated number of casualties that would be expected in the selected area if no warning was provided with the estimated number of casualties that would be expected in this area if sufficient warning is provided so that individuals can reach the appropriate shelters. The effect on casualties of not having appropriate shelters will be discussed where it is relevant. Comparisons of the estimated number of casualties with and without warning were made under various conditions of explosion. Separate estimates were generally made for ground zero due south of the area and due west of the area. The estimated casualties for ground zero due north and east of the area were not calculated as they would be approximately the same as those due south and west, respectively.

4.1 BASIC DATA.

Hospitals with special shelters and buildings with only daytime populations were excluded. The casualty estimates are based on 1,003 buildings in the selected area with an estimated population of 35,400. (c. f. Table 2.)

Census data were used to obtain the estimated population of each block in the selected area. Large scale maps were used to obtain data on the number of buildings in each block and on the relevant characteristics of these buildings, such as type of construction, number of floors, dimensions and shapes of buildings, and distances between buildings. The effects of

the different types of bombs have been estimated by using the sources described in Section 1.3 and the data presented in Section 3.6.

4.2 BASIC ASSUMPTIONS.

In making estimates of the number of casualties of various types, certain basic assumptions were made which apply to each of the various types of casualties. The special assumptions made for some particular type of casualty will be described in subsequent sections but the basic assumptions that are common to all types of casualties are described below:

(a) Estimated populations in individual buildings were obtained by distributing the census population for a particular block among the various buildings of the block, taking account of the types of buildings and the dimensions and number of floors in buildings.

(b) When there was no warning, it was assumed that the population in a building was distributed uniformly throughout the building. If sufficient warning was provided, it was assumed that the population in a building was located in a cellar shelter.

(c) In order to simplify the calculations of casualty estimates, each building in the selected area was assumed to be in the same position with regard to distance and direction from ground zero for any given set of assumptions. The simplification tends to overstate the number of casualties that would be expected as the indicated distance from ground zero was measured from the edge of the selected area.

4.3 TYPES OF CASUALTIES.

Separate estimates were made for each of the following types of casualties:

Type (a): Thermal burns from the bright flash (See Section 4.4)

Type (b): Radiation damage from gamma rays and neutrons (See Section 4.5.)

Type (c): Blast casualties from missiles and collapse of buildings (See Section 4.6.)

No attempt was made in this section to take account of duplication of casualties, so that the same individual may be counted under each of the different types of casualties. Casualties from fire have been discussed in Section 3.7.4. Casualties from contamination have been discussed in Section 3.8.

4.4 TYPE (A) CASUALTIES FROM THERMAL BURNS.

Table 5 shows the estimated number of type (a) casualties in the selected area as a result of thermal burns from the bright flash under various conditions. Type (a) casualties are defined as individuals who are exposed to nine or more calories per square centimeter. These casualties are individuals who are likely to receive at least third-degree burns.

It was assumed that the bomb burst would take place on an average clear night. The available data indicated that, without warning, the number of type (a) casualties would be negligible (there would be a few individuals with second-degree burns but none with third-degree burns) at distances from ground zero of one and one-half miles or more for a 1X bomb bursting at an altitude of 2,000 feet and at distances of four miles or more for an 8X bomb bursting at an altitude of 4,000 feet. Casualty estimates were not made for those conditions. The available information also indicated that only direct line-of-sight exposure through windows need be counted. This means that, with warning, people would be in cellar shelters without windows and the number of type (a) casualties would be negligible throughout the entire area.

On the basis of this information, estimates of type (a) casualties were made only for the without warning assumption and only for the conditions for which figures are shown in Table 5. In order to estimate the number of type (a) casualties, it was necessary to calculate first the number of people who would be in exterior rooms with windows. This calculation was made for each building in the selected area on the assumptions that the dimensions of the average room were 10 feet by 10 feet and that the estimated number of people on any floor were distributed uniformly among the various rooms.

It was then assumed that all exterior rooms had windows unless there was another building immediately adjacent to the particular building being studied. If there was no building immediately adjacent to the particular building being studied account was taken of the shading effect of the next nearest building. It was then assumed that, of the people in exterior rooms that were not shaded and that faced the bomb burst, only one-fourth would be type (a) casualties. This reflects the assumption that, on the average, the window area on an exterior wall is only about one-fourth of the wall area.

4.5 TYPE (B) CASUALTIES FROM RADIATION.

Table 6 shows the estimated number of major type (b) casualties in the selected area as a result of radiation under various conditions.

TABLE 5

ESTIMATED NUMBER OF TYPE (A) CASUALTIES IN SELECTED AREA STUDY AS A RESULT OF THERMAL BURNS FROM BRIGHT FLASH

Type (a) casualties are individuals exposed to 9 or more calories per square centimeter (i.e., enough heat to produce third-degree burns)

Distance from ground zero to each building	Direction of ground zero from each building	1X Bomb Exploded at height of 2000 feet		8X Bomb Exploded at height of 4000 feet	
		Number of Type (a) Casualties	Casualties as % of Population	Number of Type (a) Casualties	Casualties as % of Population
		Without Sufficient Warning			
½ mile	South	900	2.5	1100	3.1
	West	600	1.7	700	2.0
1½ miles	South	*	*	700	2.0
	West	*	*	500	1.4
4 miles	All	*	*	*	*
		With Sufficient Warning to Reach Shelter			
½ mile	All	*	*	*	*
1½ miles	All	*	*	*	*
4 miles	All	*	*	*	*

* Negligible number of casualties.

TABLE 6

ESTIMATED NUMBER OF MAJOR TYPE (B) CASUALTIES IN SELECTED AREA STUDY AS A RESULT OF RADIATION DAMAGE FROM GAMMA RAYS AND NEUTRONS

Major type (b) casualties are individuals exposed to 400 or more roentgen units (i.e., enough radiation to produce severe illness with at least half of casualties likely to die)

Distance from ground zero to each building	Direction of ground zero from each building	1X Bomb Exploded at height of 2000 feet		8X Bomb Exploded at height of 4000 feet	
		Number of Major Type (b) Casualties	Casualties as % of Population	Number of Major Type (b) Casualties	Casualties as % of Population
		Without Sufficient Warning			
Ground zero at building		32,900	93	32,500	92
½ mile	South	26,000	73	30,800	87
	West	20,200	57	29,200	82
1½ miles	All	*	*	*	*
4 miles	All	*	*	*	*
		With Sufficient Warning to Reach Shelter			
Ground zero at building		30,900	87	30,900	87
½ mile	South	11,800	33	18,100	51
	West	6,100	17	8,200	23
1½ miles	All	*	*	*	*
4 miles	All	*	*	*	*

* Negligible number of casualties.

Major type (b) casualties are defined as individuals who will be exposed to 400 or more r units. All of these casualties will be severely ill, and at least half of them are likely to die.

Table 7 shows the estimated number of minor type (b) casualties, that is, individuals who will be exposed to 100 or more but less than 400 r units. These casualties will experience some illness, but less than half of them are likely to die.

Table 8 shows the total number of type (b) casualties, both major and minor. These casualties are the total number of individuals who are likely to experience at least some illness.

The available data indicated that the number of radiation casualties for ranges of one and one-half miles or more are negligible for both a 1X and 8X bomb, and no estimates were prepared. Instead, special estimates were prepared for ground zero in the selected area, that is the bomb is assumed to explode directly over each building.

Available data indicated that five inches of concrete would be required to reduce the radiation by a factor of one-half. Estimates were obtained from the architect-engineers in the study group as to the equivalent number of inches of concrete in various parts of different types of buildings. These are shown in Table 9. From the available data, a computation was made of the equivalent number of inches of concrete that would be required to reduce the radiation from each of the types of bomb and positions of explosions to levels of 100 and 400 r units.

In order to determine whether the people on a particular floor of a particular building would become type (b) casualties, it was necessary to determine the equivalent number of inches of concrete that would intervene between the bomb burst and the people. This number of inches was then compared with the number of inches required to reduce the radiation to the levels indicated above.

As the amount of work involved in making detailed surveys of each floor of each building was prohibitive, the various buildings in the selected area were classified by type of building and number of floors. Detailed surveys were then made for all of certain classes of buildings (including all those with large populations) and for samples of other classes of building. About 15 per cent of the buildings with about 30 per cent of the population were surveyed in detail. Casualties in buildings that were not surveyed were estimated by assuming that the proportion of casualties would be the same as in similar buildings (same type and number of floors) that were surveyed.

TABLE 7

ESTIMATED NUMBER OF MINOR TYPE (B) CASUALTIES IN SELECTED AREA STUDY AS A RESULT OF RADIATION DAMAGE FROM GAMMA RAYS AND NEUTRONS

Minor type (b) casualties are individuals exposed to 100 or more but less than 400 roentgen units (i.e., enough radiation to produce some illness but not enough to produce a 50% fatality rate among casualties)

Distance from ground zero to each building	Direction of ground zero from each building	1X Bomb Exploded at height of 2000 feet		8X Bomb Exploded at height of 4000 feet	
		Number of Minor Type (b) Casualties	Casualties as % of Population	Number of Minor Type (b) Casualties	Casualties as % of Population
Ground zero at building		**Without Sufficient Warning**			
		500	1.4	600	1.7
½ mile	South	5,100	14	1,700	4.8
	West	6,800	19	3,000	8.5
1½ miles	All	*	*	*	*
4 miles	All	*	*	*	*
Ground zero at building		**With Sufficient Warning to Reach Shelter**			
		400	1.1	400	1.1
½ mile	South	7,600	22	11,000	31
	West	5,400	15	18,900	54
1½ miles	All	*	*	*	*
4 miles	All	*	*	*	*

* Negligible number of casualties.

TABLE 8

ESTIMATED NUMBER OF TOTAL TYPE (B) CASUALTIES IN SELECTED AREA STUDY AS A RESULT OF RADIATION DAMAGE FROM GAMMA RAYS AND NEUTRONS

Total type (b) casualties are individuals exposed to 100 or more roentgen units (i.e., enough radiation to produce at least some illness)

Distance from ground zero to each building	Direction of ground zero from each building	1X Bomb Exploded at height of 2000 feet		8X Bomb Exploded at height of 4000 feet	
		Number of Total Type (b) Casualties	Casualties as % of Population	Number of Total Type (b) Casualties	Casualties as % of Population
		Without Sufficient Warning			
Ground zero at building		33,400	94	33,100	94
½ mile	South	31,100	88	32,500	92
	West	27,000	76	32,200	91
1½ miles	All	*	*	*	*
4 miles	All	*	*	*	*
		With Sufficient Warning to Reach Shelter			
Ground zero at building		31,300	88	31,300	88
½ mile	South	19,400	55	29,100	82
	West	11,500	32	27,100	77
1½ miles	All	*	*	*	*
4 miles	All	*	*	*	*

* Negligible number of casualties.

TABLE 9

DATA REQUIRED FOR RADIATION CASUALTIES

Estimated equivalent inches of concrete by type and part of building

TYPE OF BUILDING	PARTS OF BUILDING				
	Floor over Cellar	Average Floor	Roof	Interior Wall	Exterior Wall
	(in inches)	(in inches)	(in inches)		(in inches)
1. Protective—Residential	4	4	4	*	6
2. Semi-Protective—Residential	4	*	*	*	6
3. (a) Nonprotective Multiple Dwelling	*	*	*	*	6
3. (b) Nonprotective 1 and 2-Family Dwellings	*	*	*	*	6
3. (c) Nonprotective Old-law Tenement	*	*	*	*	6
5. (a) Institutional Fireproof	4	4	4	*	6
5. (b) Institutional Nonfireproof	*	*	*	*	6

* Negligible equivalent amount of concrete

In surveying a floor of a particular building, account was taken of the protection provided by intervening floors and walls of that building and also of any nearby building. The population on an individual floor was assumed to be concentrated in the middle of the floor. Very large buildings were broken down into parts of buildings, which were then surveyed individually.

4.6. TYPE (C) CASUALTIES FROM BLAST.

There was very little reliable data which could be used in estimating the number of casualties from blast. The casualty estimates are, therfore, rather crude and based largely on judgment and an interpretation of the physical damage estimates described in Section 3.6.

Table 10 shows the estimated number of casualties from flying missiles. These casualties are defined as individuals who would be injured by shattered glass and light debris. From the calculations made for type (a) casualties, it was possible to determine that about 55 per cent of the total population in this area would be located in exterior rooms with windows if no warning were provided. It was assumed that all windows on all sides of any building would be broken if the bomb burst within four miles in any direction.

The following proportions of people in exterior rooms were then assumed to be casualties as a result of flying missiles:

Distance	1X bomb	8X bomb
½ mile	50%	60%
1½ miles	30%	40%
4 miles	10%	20%

The higher percentages for the shorter distances and larger bombs reflect higher peak pressures and presumably higher velocities and greater proportion of flying glass and debris.

Table 11 shows the estimated number of type (c) casualties from building collapse. These casualties are defined as individuals who would be injured by falling walls, floors, and heavy debris. Based on data in Section 3.6, the following factors could be used to estimate the number of casualties from collapsing buildings.

TABLE 10

ESTIMATED NUMBER OF FLYING MISSILE TYPE (C) CASUALTIES IN SELECTED AREA STUDY AS A RESULT OF BLAST FROM SHOCK WAVE

Flying missile type (c) casualties are individuals who are expected to receive at least minor injuries from flying glass, etc.

Distance from ground zero to each building	1X Bomb Exploded at height of 2000 feet		8X Bomb Exploded at height of 4000 feet	
	Number of Flying Missiles, Type c Casualties	Casualties as % of Population	Number of Flying Missiles, Type c Casualties	Casualties as % of Population
	Without Sufficient Warning			
½ mile	9,900	28	11,800	33
1½ miles	5,900	17	7,900	22
4 miles	2,000	5.6	3,800	11
	With Sufficient Warning to Reach Shelter			
½ mile	*	*	*	*
1½ miles	*	*	*	*
4 miles	*	*	*	*

* Negligible number of casualties.

TABLE 11

ESTIMATED NUMBER OF FALLING BUILDING TYPE (C) CASUALTIES IN SELECTED AREA STUDY AS A RESULT OF BLAST FROM SHOCK WAVE

Falling Building type (c) casualties are individuals who are expected to receive at least minor injuries from the collapse of any part of a building

Distance from ground zero to each building	1X Bomb Exploded at height of 2000 feet		8X Bomb Exploded at height of 4000 feet	
	Number of Falling Building Type (c) Casualties	Casualties as % of Population	Number of Falling Building Type (c) Casualties	Casualties as % of Population
	Without Sufficient Warning			
½ mile	32,300	91	33,200	94
1½ miles	19,300	55	30,000	85
4 miles	9,900	28	16,400	46
	With Sufficient Warning and No New Shelters			
½ mile	30,900	87	31,100	88
1½ miles	18,500	52	28,600	81
4 miles	9,400	27	15,700	44
	With Sufficient Warning To Reach Adequate Shelter			
½ miles	6,400	18	16,000	45
1½ miles	3,200	9.0	6,400	18
4 miles	1,500	4.2	3,200	9.0

FACTORS FOR ESTIMATING CASUALTIES FROM COLLAPSING BUILDINGS

Distance from ground zero	Building Types 1,5a,		Building Types 2, 3a, 3b, 3c, 5b	
	1X bomb	8X bomb	1X bomb	8X bomb
	Without sufficient warning—all people on the indicated number of top floors will be casualties			
1/2 mile	4 floors	8 floors	6 floors	10 floors
1½ miles	2	4	3	5
4 miles	1	2	1½	2½
1½	With sufficient warning—indicated percentages of all people in building s will be casualties			
1/2 mile	5	15	20	50
1½ miles	2.5	5	10	20
4 miles	0	2.5	5	10

The percentages shown under the heading "with sufficient warning" are based on the assumption that the proposed types of shelters will be available. In order to calculate estimated casualties for the "with sufficient warning and no new shelters" condition, we used the data under "without sufficient warning" for building types 2, 3a, 3b, 3c and 5b and the data under "with sufficient warning" for building types 1 and 5a. This reflects the fact that the weight of debris may cause the collapse of nonprotective buildings on people in cellars if adequate shelters are not provided.

4.7 CONCLUSIONS.

Table 5—If ground zero is one-half mile or more from building, casualties as a result of thermal burns will be relatively light without warning and negligible with warning. Shelters have relatively little effect, as normal cellars will provide adequate protection against thermal burns without new shelter.

Table 6—If ground zero is at building, major radiation casualties will be very heavy with or without warning. The only people who will escape injury will be those near ground in very high protective buildings. If ground zero is one-half mile away, then major radiation casualties will be relatively heavy without warning but will be reduced sharply if sufficient warning is provided. Proposed shelters will provide little additional protection against radiation.

Table 7—It should be noted that a small number of minor radiation casualties generally reflects a large number of major radiation casualties.

Table 8—Total number of radiation casualties is reduced by warning, but the reduction is not as great as for major radiation casualties. Warning converts many major radiation casualties into minor ones.

Table 10—Sufficient warning will eliminate almost all flying missile type (c) casualties.

Table 11—Sufficient warning will greatly reduce casualties due to collapse of buildings provided that adequate shelters are provided. Warning by itself will not help much if shelters are not adequate to provide some protection against heavy debris.

5. SUMMARY AND RECOMMENDATIONS.

The study, by itself, has lead to a number of conclusions and recommendations. These have been further sharpened when they were reviewed in the light of closely related results from other portions of the PROJECT EAST RIVER study.

5.1 INFORMATION.

Recommendation: *The Federal Civil Defense Administration should give greater emphasis to a program that will provide the data needed for sound civil defense planning at all levels. Particularly, the Federal Civil Defense Administration should: (a) conduct, through arrangements with appropriate government agencies, experiments designed to provide essential data; (b) publish or otherwise distribute such data*

promptly and in an unclassified form; and (c) act as a clearing house to advise local civil defense organizations of procedures that have been successfully employed elsewhere and of any new and promising methods derived from research and development work.

The study has demonstrated clearly that the fundamental weakness in many of the PROJECT EAST RIVER discussions, and presumably throughout civil defense, is a lack of detailed factual information. This information cannot be obtained easily, through synthesis or other artificial means. There is a need for more on-the-spot detailed work to provide basic data that will eliminate uncertainties and irrefutably document civil defense plans and proposals. Some detailed basic data, such as weapons effect data, are common to most civil defense problems. It should be the responsibility of the Federal Civil Defense Administration to see that such data are available. Other data are characteristic of the locality. The Federal Civil Defense Administration can provide guidance, but the real initiative and the responsibility with respect to local data properly rest with the local civil defense organization.

Recommendation: The Federal Civil Defense Administration should see that the best sources of basic data, the United States Strategic Bombing Survey Reports on Hiroshima and Nagasaki, are re-published without abridgement and made available at cost; that essential data from more recent tests are unclassified and made available; that the portions of the results of analyses and investigations by military or other agencies[1] *that are particularly relevant to civil defense are lifted from the classified military context and re-issued in unclassified form.*

There is a particularly acute lack of detailed data concerning the physical damage resulting from an A-bomb attack. Some data exist but are not generally available at local levels. For example, the reports of the United States Strategic Bombing Survey in Hiroshima and Nagasaki provide the only genuine full-scale test data but these reports are out of print. More recent tests conducted at the Pacific and Nevada test stations have undoubtedly yielded data essential for civil defense, but most of these results are shrouded in military secrecy. The Hiroshima and Nagasaki data have been re-examined by numerous groups with results of great civil defense interest, but these results are intermingled with matters concerning military problems and, hence the entire reports are classified and unavailable.

[1]c.f. ORO Technical Report T-87, Volume I, and Rand Memo RM-820, dated 1 May 1952.

5.2 SHELTERS.

Recommendation: The Federal Civil Defense Administration should review its shelter program to clarify objectives and to simplify procedures.

The analysis procedure devised by the Federal Civil Defense Administration for use in making local shelter surveys is so detailed and complicated than even experts in the building field find it difficult to follow the instructions. The net result is that an unnecessary hurdle has been placed in the way of even elemental shelter programs. Our study has clearly demonstrated that the simplest kind of shelters at relatively low cost can significantly reduce the number of casualties. In our opinion, this simple step should be taken first, before construction is started on large public shelters.

The study has demonstrated that in predominantly residential areas, private small shelters are preferable to large public shelters. Any shelter program requires the following elements:

(a) Analysis of requirements and capabilities in the local area. PROJECT EAST RIVER believes than an analysis can be made at any locality, utilizing local talent (architects, engineers, etc.) and readily available data on population and structures; this presumes availability of good weapons effects data and information on effective analysis procedures through the Federal Civil Defense Administration; (b) warning time sufficient to permit the public to utilize the shelters provided; (c) communications between the civil defense headquarters and the public in the shelters; (d) public participation, including preparation of shelter areas, prompt precautionary measures when the alert is given, and intelligent actions if an attack materializes; and (e) education and training of the public to achieve the ends listed above.

5.3. FIRES.

Recommendation: The Federal Civil Defense Administration should initiate or enlarge existing programs aimed at a better understanding of fire problems: the relative importance of primary and secondary fires, the probable incidences of the two types of fires, preventive measures, controls, and the mechanism of fire storms.

It is our understanding that a considerable amount of work is underway, as part of the joint Atomic Energy Commission—Department of Defense test programs, that will help to relieve the existing acute lack of authoritative data concerning many aspects of the fire problem. The

Federal Civil Defense Administration should support and participate in this work. (See Part III of PROJECT EAST RIVER Report, "The Destructive Threat of Atomic Weapons.") Some portions of the fire problem are controversial issues. These cannot be solved by ignoring them. Critical, objective studies must be made.

5.4. CONTAMINATION.

Recommendation: The Federal Civil Defense Administration should review the over-all problem of contamination and should urge local civil defense groups to make predisaster surveys, emphasizing particularly the need for a careful meteorological survey in the YELLOW alert period, and the requirement that the location and nature of the A-bomb attack be determined promptly.

The public is badly confused concerning the hazard of contamination as compared with other types of hazard resulting from an A-bomb attack. An educational program is necessary, aimed at the local civil defense organizations and the public. As a few minutes may be very important to the public in taking proper actions, the civil defense headquarters must be prepared to decide, without delay of lengthy consultations, what the proper action of the public should be and at what time with respect to the bomb burst these actions should be taken.

5.5. POST-ATTACK COMMUNICATIONS.

Recommendation: The Federal Civil Defense Administration should emphasize the need for rapid, direct communications between the civil defense headquarters and the public in shelters.

The importance of warning time is discussed in other parts of the report of PROJECT EAST RIVER and is again demonstrated by this study in a comparison of casualties, with and without warning. It is feared, however, that sufficient recognition has not been given to the requirements of rapid communications at the local level in the immediate post-disaster period. The telephone network, discussed in Parts VI and VII of the report of PROJECT EAST RIVER, serves as an adequate channel for communication from the block wardens (and the public) to the local civil defense headquarters. This same channel may serve in the opposite direction, but it will be slow if the general public is distributed among the many small shelters proposed in Section 2.7. To overcome this difficulty, radios seem to offer the best channel. Whether standard, portable or miniature models are used, they must be in the shelters when needed, and probably some crude antenna will be necessary

to insure adequate reception of the reduced-power transmission of the Conelrad condition. As electric power may be disrupted after an attack and as television has greatly reduced population of operable radios in metropolitan areas, the Federal Civil Defense Administration should urge the production of small, cheap battery-operated radios that might be installed permanently in a shelter, along with a first-aid kit, gas masks, and a small reserve of food and water.

5.6. CASUALTIES.

Casualty estimates have been made separately for each of the major causes. It is true, of course, that a single individual may be a casualty from more than one cause. To account for this possible overlapping and to arrive at a meaningful total estimate of casualties, the results have been combined, percentage wise, by starting with the 100 per cent population, deducting the appropriate percentage of type (a) casualties; applying to the remainder the percentage for type (b) casualties and deducting this amount, giving a new remainder; applying to the new remainder the percentage of type (c) casualties, and deducting this amount, thus obtaining the percentage of the population that will not be casualties from any cause. This percentage of non-casualties subtracted from 100 per cent gives the percentage of total casualties from all causes. It is obvious that people sheltered in a reinforced steel and concrete structure who survived one type of casualty would also have a good chance of surviving other types of casualties, as compared to persons in nonprotective buildings. Thus, the proposed calculation was not made for all types of buildings combined. The population was divided into the five types of structures listed in Section 2.3, and the calculation was made for each group separately and then combined to form total casualties. These results are shown graphically in Figures 2 and 3. It is important to note in Figures 2 and 3 that the total casualties *do not* include any casualties by fire burns or by radiation from contamination. These are two important causes of casualties, but our information is too indefinite to permit casualty estimates of any certainty. Also, it is important to note that these figures are prepared for an area of fixed size. In an actual bomb burst, the situation at any given distance from ground zero would apply, generally, to a ring of radius equal to the distance from ground zero. For this actual situation, Figures 2 and 3 apply, provided one speaks of the percentage of population at each distance from ground zero and not percentage of the total population affected by the bomb.

These figures clearly demonstrate the importance of warning time and the still greater gains possible if this warning is combined with a shelter program. An examination of the table for the individual types

FIGURE 2

1X BOMB EXPLODED at HEIGHT of 2000 FEET

AT VARIOUS DISTANCES SOUTH of SELECTED AREA

ESTIMATED % OF POPULATION IN SELECTED AREA
WHO WILL BE CASUALTIES FROM THERMAL BURNS,
MAJOR RADIATION DAMAGE, FLYING MISSILES OR FALLING BUILDINGS

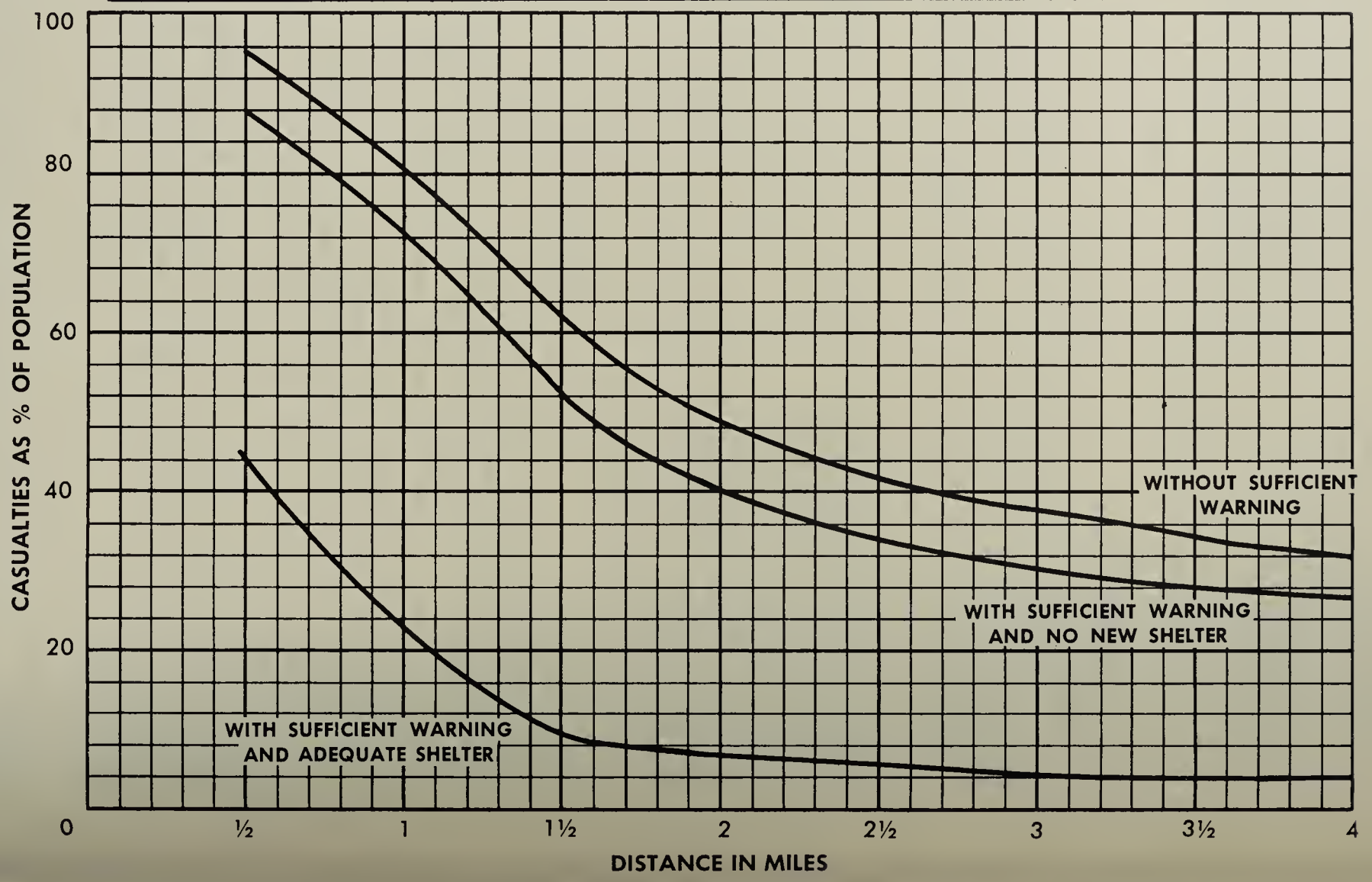
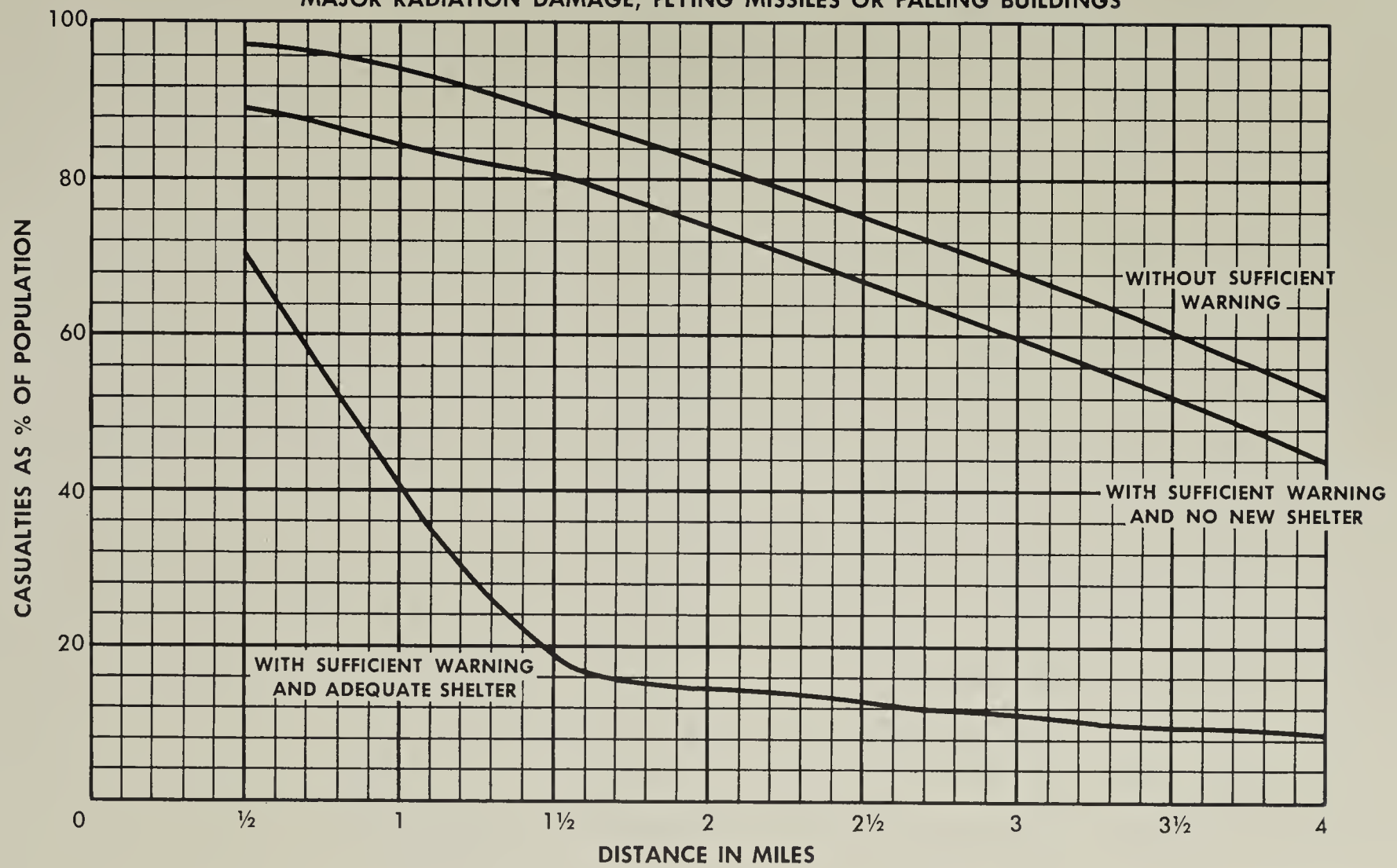


FIGURE 3

8X BOMB EXPLODED at HEIGHT of 4000 FEET

AT VARIOUS DISTANCES SOUTH of SELECTED AREA

ESTIMATED % OF POPULATION IN SELECTED AREA
WHO WILL BE CASUALTIES FROM THERMAL BURNS,
MAJOR RADIATION DAMAGE, FLYING MISSILES OR FALLING BUILDINGS



of casualties shows that warning alone can greatly reduce casualties from the thermal flash and, to a somewhat lesser degree, casualties from flying glass and missiles and from radiation. Warning time alone can practically eliminate all thermal flash casualties, *provided* the public has been educated or trained to respond to the warning. Casualties from burns (fires) can be significantly reduced *provided* that there is warning time to permit precautionary measures before the attack; adequate communications exist to insure that civil defense headquarters may keep the public advised of the disaster situation; and the public is prepared to fight fires or take other appropriate actions at appropriate times.

Close to ground zero, radiation casualties will be heavy, if our decision is proper that total protection is economically unfeasible. Radiation casualties from residual contamination can be significantly reduced *provided* that there is a direct channel of communications between civil defense headquarters and the public; civil defense headquarters is prepared to obtain and analyze information at the time of the attack and to decide promptly what actions the public should take to minimize casualties; and the public is educated and prepared (radio) to listen to civil defense broadcasts and to act intelligently.

Warning alone can greatly decrease the number of casualties from flying glass and other missiles. With shelters, missile casualties are almost eliminated. Warning alone will not greatly reduce casualties from the collapse of buildings. The shelter program makes its greatest contribution here.

The study has demonstrated the need for a balanced civil defense program. Warning alone prevents some types of casualties but the persons saved will probably become victims of another type. A balanced program providing warning, shelters, and public education and training will greatly improve the individual's chances of survival in the event of an atomic attack.

MINIMUM DENSITY AND SPACING REQUIREMENTS FOR METROPOLITAN DISPERSION; FORCES MAKING FOR CONCENTRATION IN THE CORES OF METROPOLITAN AREAS

Appendix V-B
to
Part V of the
Report of
PROJECT EAST RIVER

Prepared under Signal Corps Contract No. DA-49-025-SC-96

Associated Universities, Inc.
New York, New York

PREFACE

The frame of reference of these reports (Section I and Section II) was twofold: first, to suggest standards of density and spacing for metropolitan dispersal; second, to analyze forces making for concentration or dispersal and suggest policies which could be utilized to accelerate dispersal.

The consultants were required to prepare these reports within six weeks. As a consequence all the conclusions must be regarded as preliminary. If time and resources had been available, much more systematic studies could have been made.

A study entitled *Recent Locational Tendencies in United States Industry*, by Walter Isard and Robert A. Kuenne, was utilized in Section I, and reference is made thereto. The authors acknowledge the generous contributions of Walter Isard and Robert A. Kuenne. C. McKim Norton and Burnham Kelly, consultants to PROJECT EAST RIVER, initiated and advised on the work.

Section I was prepared by William L. C. Wheaton, with the assistance of Calvin S. Hamilton, of the Department of Regional Planning of Harvard University. Section II was prepared by Coleman Woodbury, Charles Dyer Norton, Professor of Regional Planning, Harvard University, with the assistance of Morton J. Schussheim, of the Department of Regional Planning of Harvard University.

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SECTION I

MINIMUM DENSITY AND SPACING STANDARDS FOR METROPOLITAN DISPERSION

A. RESIDENTIAL LAND USE AND DENSITY

Land Use

This section reviews briefly the relationship between population density in urban areas and land use and building density. Estimates are given of the probable density ranges of future development in or around American cities.

Population density in urban areas varies with the proportion of land in developed residential use and with the density of that use. Family size and occupancy may be important variables in special situations, but usually not in suburban areas. For various reasons, from 20 to 80 per cent of the land of most cities is undeveloped.[1] Because of the large amount of land available for development in the environs of all of our metropolitan areas it is likely that similar ratios of undeveloped land will persist in the future.

Of the developed urban land Bartholomew found that from 27 to 54 per cent was used for residential purposes. The following table shows average conditions.

Table 1
Average Developed Urban Land Use Ratios in Six Satellite Cities and 16 Self-Contained Cities from 1920 to 1930

Land Use	Self-Contained Cities	Satellite Cities
Residential	39.3	48.2
Commercial	2.4	1.4
Industrial and Railroad	10.8	10.3
Streets	33.6	29.7
Parks and Playgrounds	6.3	1.3
Institutional and Public	7.6	9.1
Total	100.0	100.0

Source: Bartholomew, *op. cit.*

[1] Bartholomew, Harland. URBAN LAND USES, Harvard University Press, 1930.

Despite the limitations of these data and the need for more current and extensive information, there appears to be no grounds for assuming very different ratios of land use in peripheral areas in the future. The residential ratios in particular should be relatively stable. Despite increases in land requirements in almost all uses, distribution ratios need not be affected. These ratios have been adopted with minor modifications in the tables which follow.

Residential Density

Existing residential areas in the United States vary in gross density from the 100,000 persons to the square mile on Manhattan Island to the 300 persons per square mile found in many country-estate suburban areas. While higher densities are found in some city blocks, or groups of blocks, the most crowded areas of square-mile size in major cities will contain from 40,000 to 60,000 people. Such areas will consist of fully developed and closely spaced three- and four-story apartments with scattered elevator structures.

More typical urban residential areas of 25,000 persons to the square mile are covered by closely spaced two- and three-story buildings. Crowded residential areas of single and semi-detached houses will have densities of 10,000 to 15,000 per square mile. Fully developed areas of small single- and two-family homes on small lots will run from 5,000 to 10,000 persons to the square mile. Densities of 2,000 to 5,000 people arise in areas of single homes on generous lots. The dwelling type, size of lot, and the coverage of the buildings are the major determinants of these densities in residential areas.

For purposes of this study, it has been assumed that the dwelling types and coverage of land by buildings will conform to current practices in the building industry. The most important of these assumptions are: single-family homes on 5,000- to 15,000-foot lots; semi-detached homes on 3,000- and 5,000-foot lots; row houses on 3,000-foot lots; and walk-up or garden apartments with 10 and 25 per cent coverage of the building site.[2]

Population Density

Densities are sharply reduced by the inclusion of land used for other purposes. Population densities for whole cities therefore range from 25,000 persons per square mile in New York City to less than

[2] These standards conform generally to, but are somewhat below, those prescribed by the AMERICAN PUBLIC HEALTH ASSOCIATION IN PLANNING THE NEIGHBORHOOD, Public Administration Service, Chicago, 1948.

1,000 persons per square mile in smaller cities in all parts of the country. Boston and Chicago average 16,000; Baltimore and Washington, 10,000; Mobile, Kansas City, and Memphis, 6,000; and Los Angeles and Des Moines, 3,000 persons to the square mile.

The gross population density of urban areas which will be developed in the future will be influenced by four major forces: public regulation, consumer preference, changing transportation technology, and public and private economic forces. Public regulation should prevent excessive densities in future developments and may also put a floor under densities by creating farm belts around suburban communities. Consumer preferences for single homes, lower density apartments, and suburban locations have already reduced densities in recent building. The almost universal use of the automobile has made a wide dispersal of residences possible, and opened up vast areas to urban development Finally, increasing costs of construction, of municipal services, and of transportation may set limits upon the consumer's preference for space in residential areas.

Table 2 which follows shows the theoretical gross population densities which could arise in future urban areas for different dwelling types and degrees of urban development. The table is based upon the assumptions stated above with respect to developed land, land use ratios, residential density standards, and consumer preferences. The table applies to the peripheries of our metropolitan areas and to new communities, not to existing cities.

The range of densities shown on Table 2 is from 33,100 persons per square mile in highly developed areas with relatively high coverage walk-up apartments to 300 persons per square mile in slightly developed areas of suburban homes with acre lots. This upper limit exceeds the actual realized over-all density in the most densely populated city of the United States, and this lower limit is nonurban as urban areas are defined by the census. With these two cases eliminated, all other cases on the table are theoretically possible. The table reveals that gross densities in cities of single detached homes with small or moderate sized lots will range from 800 people to 5,500 people to the square mile, depending upon the degree of development of the community. As other types of dwelling units predominate, densities of up to 10,000 or 15,000 persons to the square mile might arise. It is improbable, of course, that communities will be built consisting of only one dwelling type.

Table 2

Theoretical Population Densities per Square Mile for Complete Communities of Various Dwelling Types under Various Conditions of Development and Residential Density Standards

(Average family size = 3.1 persons)
All figures rounded

State of Development and Lot Size	Population per Square Mile			
	DWELLING TYPE			
	3-story[a] Walk-up Apt.	Semi-detached	Row house	Single detached house
Highly developed (80%)[b]				
3,000-square foot lot		14,100	7,000	
5,000-square foot lot		11,000		5,500
15,000-square foot lot	33,100			1,800
40,000-square foot lot	12,400			700
Moderately developed (50%)[c]				
3,000-square foot lot		9,900	5,000	
5,000-square foot lot		7,800		3,900
15,000-square foot lot	23,300			1,300
40,000-square foot lot	8,700			500
Slightly developed (30%)[d]				
3,000-square foot lot		6,600	3,300	
5,000-square foot lot		5,200		2,600
15,000-square foot lot	15,500			900
40,000-square foot lot	5,800			300

[a] Assumed net residential density is 52 D.U.'s per acre on 15,000-foot lots with approximately 25% coverage; 15 D.U.'s per acre on 40,000-foot lots with 10% coverage.

[b] For highly developed communities it is assumed that 80% of the gross area is developed and that 40% of developed area is residential.

[c] For moderately developed communities it is assumed that 50% of the gross area is developed and that 45% of developed area is residential.

[d] For slightly developed communities it is assumed that 30% of the area is developed and that 50% of developed area is residential.

In Table 3 the element of mixture of dwelling types is introduced. Three mixtures are assumed. The low-density mixture corresponds roughly to the present output of the building industry with 80 per cent single detached and row houses, 5 per cent semi-detached, and 15 per cent apartments.[3] If this pattern of building is continued in future urban development, the indicated densities are from 2,500 to 6,700 persons per square mile.

The moderate-density corresponds roughly to the output of the building industry during the 1920's. The proportion of single homes is somewhat lower, at 60 per cent, while the proportions of semi-detached and apartment units are higher, at 20 per cent each. This mixture produced densities of 2,800 to 7,800 persons per square mile depending upon percentage of developed area. The final example corresponds in part to the existing distribution of buildings in east coast cities. Single homes constitute only 40 per cent of the total, while the proportions in other types have been set at 15 per cent row, 20 per cent semi-detached, and 25 per cent apartment units to reflect conditions in cities where these types make up substantial parts of the housing supply. Since these ratios of dwelling types are not currently built, the example illustrates what a relatively high-density alternative would produce. It results in densities ranging from 3,400 to 8,400 persons to the square mile.

In the above cases the maximum figure shown assumes that all single homes are on 5,000-foot lots. The minimum figure assumes large lots (15,000 square feet) for 10 per cent of the single homes in the two lower density mixes, 5 per cent for the high mix. Small lots are assumed for semi-detached and low coverage for apartments. These might be characterized as most probable assumptions under prevailing conditions.

CONCLUSIONS

If present patterns in the building industry continue, and if the other assumptions of this report are accepted, future urban development may be expected to result in gross densities of 2,500 to 5,400 person per square mile, depending upon the degree of development in the community.

If changes in the types of building produced were to result in a return to the "mix" of the 1920's, but with modern types and densities substituted for those then prevailing, the maximum densities for urban areas resulting would be 7,800 persons per square mile.

[3] Cf. HOUSING AND HOME FINANCE AGENCY, FOURTH ANNUAL REPORT, Washington, 1950. p. 106, Table 2; and HOUSING STATISTICS HANDBOOK. 1948, p. 47, Table 37.

It appears highly improbable that peripheral development around cities in this coutry will exceed 7,800 persons per square mile unless there are quite unanticipated changes in the building economy of the United States.

Table 3

Prospective Population Densities per Square Mile for Complete Communities under Current and Alternative Building Conditions

(Average family size = 3.1 persons)
All figures rounded

Distribution by Dwelling Types	Population per Square Mile					
	Highly Developed[a]		Moderately Developed[a]		Slightly Developed[a]	
High-Density Mixture[b] 40-15-20-25	Min.[e] 7,300	Max. 8,400	Min. 5,100	Max. 5,900	Min. 3,400	Max. 4,000
Moderate-Density Mixture[c] 50-10-20-20	6,100	7,800	4,300	5,500	2,800	3,600
Low-Density Mixture[d] 70-10-5-15	5,400	6,700	3,800	4,700	2,500	3,100

[a] Development assumes: 80% of land area developed for high;
50% of land area developed for moderate;
30% of land area developed for slightly.

[b] High-density mixture: 40% single detached (5% on large lots);
20% semi-detached;
10% row houses;
20% apartments.

[c] Moderate-density mixture: 50% single detached (10% on large lots);
20% semi-detached;
10% row houses;
20% apartments.

[d] Low-density mixture: 70% single detached (10% on large lots);
5% semi-detached;
10% row houses;
15% apartments.

[e] Minimum estimates assume percentages stated above of single houses on 15,000-foot lots. Maximum estimates assume that no single house has a lot larger than 5,000 sq. ft.

B. THE JOURNEY TO WORK

Urban and industrial societies require concentrations of population sufficient to assemble relatively large forces of labor in manufacturing plants and trade and service areas. To the extent that transportation facilities are available the population required to supply any given volume of employment may be more widely dispersed. The time, distance, cost and inconvenience of journeys to work limit the extent of possible dispersion.

Comparatively cheap and rapid mass transit facilities make possible very large concentrations of labor where alternative methods of travel are not available, and where population densities are high enough to generate large volumes of traffic. In recent years competition from private automobiles and the lowered density of new residential areas have reduced the competitive advantage of mass transit systems, at least on counts of time and inconvenience. As a result, the use of public transit has declined steadily, and the use of the automobile has increased rapidly.[4] This has occurred in spite of the fact that the cost of mass transit is as little as one-tenth that of automobile travel.[5]

There have been few systematic studies of the journey to work in this country. The leading work was based upon war and prewar data. Despite the need for a more current study, several major trends appear to be established. "There is a general tendency for the number of workers to vary inversely with distance from the plant site."[6] The number of workers falls off sharply beyond 20 minutes' driving time and 30 minutes of street car or bus time. More than half of employees live within three miles of the plant, and proximity of residence to place of employment increases with the duration of employment. The following table illustrates some of these points.

The length and time of journey to work increase with both size of plant and size of city.[7] Carroll found that approximately two-thirds of the employees of industries in cities of 10,000 to 25,000 population were residents of the city. He suggests that primary, self-con-

[4] TRANSIT FACT BOOK. American Transit Association, New York City, 1951, Table 4.

[5] THE COST OF DRIVING TO WORK IN SAN FRANCISCO. San Francisco Department of City Planning, 1951. cf. also AUTOMOBILE FACTS AND FIGURES. Automobile Manufacturers Association, 29th ed. Detroit, 1949. p. 38.

[6] Carroll, J. Douglas, Jr., HOME-WORK RELATIONSHIPS OF INDUSTRIAL EMPLOYEES, unpublished Ph.D. Dissertation, Harvard University, 1950, p. 130.

[7] *Ibid.*, p. 164.

tained cities of over 10,000 population and beyond regular commuting distance of other cities would house 60 per cent of the employees of local industry.[8]

Table 4

Elapsed Time of Trip to Work by Method of Transport for all Principal Wage Earners in 64 Cities — 1934 Showing Per Cent of all Users of Selected Methods of Transport in Successive Time Zones between Home and Work

Usual Method of Transport to Work	Time Required for Trip from Home to Work (Minutes)								
	1-10	10-19	20-29	30-39	40-49	50-59	60-89	90+	Total
Walk	17	43	21	14	3	*	2	*	100
Auto	1	52	25	11	2	*	2	*	100
St. Car & Bus	1	19	29	29	12	1	8	2	100
Percentage of Total	8	40	25	17	5	*	4	1	100

* Less than .5 per cent.

Source: Compiled from data for individual cities in United States Department of Commerce, Bureau of Foreign and Domestic Commerce, REAL PROPERTY INVENTORY—64 CITIES, Washington, D. C., Government Printing Office, 1935.

More recent studies indicate that the proportion of workers driving to work has increased sharply during the postwar period to as much as 65 to 75 per cent of all employees in some communities.[9] The more rapid decline of mass transit riding in smaller than in larger cities would indicate that this is particularly true outside of major metropoli. There is evidence that secondary wage earners work closer to home than primary workers, presumably in part because the latter use the family auto.

CONCLUSION

The available evidence seems to support the following conclusions and premises for purposes of this report:

(1) That overtime workers will tend to locate residentially as close as possible to their place of employment.

[8] *Ibid.*, p. 150.

[9] Massachusetts State Planning Board, Preliminary Report of Transportation Survey, Boston, 1942, p. 3; and Beyer, Glenn H., HOUSING AND THE JOURNEY TO WORK, Ithaca, 1951, p. 13.

(2) That not more than 40 per cent of the workers living in any community may be expected to commute to another community for employment.

(3) That manufacturers must expect to recruit more than half of their employees from areas within 20 minutes' drive or 30 minutes' bus ride of the plant, and that in smaller cities less than 10 per cent and in larger cities less than 25 per cent of employees can be recruited from distances of more than 30 minutes' driving time or 40 minutes' bus time from the plant.

(4) That to the extent that proximity of employment and residence is achieved, the potential labor supply available will be increased by additions of secondary workers from the community.

(5) That both because of the very high costs to the worker and the potential drain on exhaustible and short resources during periods of national emergency, patterns of population distribution which encourage the possibility of public transit systems should be preferred. Such patterns, if they are to achieve speed and economy, must permit widely spaced stops around population centers of moderate density.

In the following sections driving times of 20 and 30 minutes are assumed: 20 mph in urban areas and 40 mph in rural areas. These assumptions correspond roughly to bus rides of 30 and 40 minutes and are therefore within assumed recruitment limits for 75 per cent of employees under normal circumstances.

C. SIZE AND COMPOSITION OF LABOR MARKET AREAS

Any plan for the dispersal of urban population must assume a continuation of the economic life which supports the existence of cities. Any dispersal pattern must accommodate normal ratios of basic employment in industry, secondary employment in wholesale and retail trade, and tertiary employment in essential community services. The dispersal plan must allow the recruitment of labor to meet these needs and permit the location of industry in areas having adequate potential labor supplies. The plan must not be self-defeating in that it generates a repetition or re-establishment of conditions of concentration which dispersal policy would seek to avoid.

There has been no adequate study of the distribution of employment as between basic industry, trade, and service occupations in local areas. Such studies as have been made relate to cities of metropolitan size

rather than to smaller communities.[10] A preliminary study of 27 cities reveals differences between independent cities and satellite cities with respect to total employment and ratios in manufacturing, trade, and service occupations. The ratios also vary by population size of the community involved. Despite their inadequacies and the limited sample of cities used, these data have been converted to produce Tables 5 and 6 which follow. The ratios suggested and utilized in the remainder of this report are believed to be conservative with respect to basic employment, and tend to overstate the populations that would result from a dispersal of manufacturing into suburban or satellite areas.

Table 5

Prospective Numbers of Employed Workers, and Number of Basic, Service, and Retail-Wholesale Workers for Satellite Cities of Various Population Sizes

Figures Rounded

City Population		Total Employment[a]	Basic Workers	Service Workers	Retail & Wholesale Workers
10,000		3,730	1,380	1,700	650
20,000		7,460	2,760	3,300	1,300
30,000		11,190	4,140	5,100	1,950
40,000	Low	14,910	5,520	6,800	2,600
	High	15,750	9,110	4,480	2,200
50,000	Low	18,650	6,900	8,500	3,250
	High	19,740	11,350	5,600	2,750
60,000		23,640	13,620	6,720	3,300
70,000		27,500	15,890	7,840	3,850
80,000		31,520	18,160	8,960	4,400
90,000		35,460	20,430	10,080	4,950
100,000		39,400	22,700	11,200	5,500

Source: Based upon an unpublished study of 27 cities in the United States, 1940.

[a] Employment percentages in eight satellites with average population of 30,000 were used for the population groups 10,000 to 50,000 by linear interpolation. Percentages in six satellites with average population of 50,000 were used for population groups 50,000 to 100,000.

[10] Cf. Hoyt, Homer, ECONOMIC BACKGROUND OF CITIES, Journal of Land and Public Utility Economies, vol. 17, May 1941; and Bureau of Labor Statistics, EMPLOYMENT, HOURS AND EARNINGS: STATE AND AREA DATA, vol. 1, Area Employment 1950. Washington, 1950, p. ix.

Table 5 suggests that the total employment in satellite communities varies from 370 to nearly 400 workers per 1,000 population. Total employment is unlikely to exceed these ratios substantially over any long period of time in any satellite community. The proportion in basic employment, chiefly manufacturing, varies from 138 to 227 per 1,000. These ratios in basic industry, however, could be substantially higher, especially in the formative years of industrial satellites. The general magnitude of possible shifts is suggested for the median class intervals. To the extent to which this is true, manufacturers would find larger labor supplies, or the populations or densities could be somewhat lower than those suggested in this report. It should be stressed that the employment ratios used herein are preliminary.

Table 6 indicates the total population that may be expected to result from given employment volumes in basic industry, again based upon existing ratios in a sample of American cities. The table suggests the extent to which industrial dispersal may ultimately result in dispersal of population. It also emphasizes the necessity of limiting the size of industrial agglomerations if total populations in continuously built-up cities are to be maintained at levels below those of a metropolitan size. Concentrations of more than 10,000 basic workers may ultimately produce total populations of 50,000 people or more in normally balanced

Table 6

Prospective Satellite City Populations, Numbers of Employed Workers, Service Workers and Retail-Wholesale Workers for Various Numbers of Workers in Basic Industry

All Figures Rounded

Total Number of Basic Workers	Total City Population	Total Employment	Service Workers	Retail & Wholesale Workers
1,000	7,240	2,700	1,230	470
3,000	21,740	8,110	3,690	1,410
6,000 Between—	26,430	10,430	3,070	1,450
	43,470	16,200	7,380	2,820
9,000 Between—	39,640	15,620	4,540	2,180
	65,300	24,380	11,100	4,240
12,000	52,860	20,820	5,920	2,900
15,000	66,080	26,040	7,400	3,630
18,000	79,390	31,180	8,860	4,350
21,000	92,510	36,420	10,360	5,080

Source: Adapted from Table 5.

communities. Only a network of communities, properly spaced, can provide labor force pools for basic industry in sizes of above 10,000 workers, if city size is to be limited. Concentrations of 1,000 to 6,000 basic workers would appear to result in communities of 7,000 to 40,000, presumably a desirable size from the standpoint of this report.

It should be noted that larger concentrations of basic employment do exist with smaller total populations that those suggested here. Such communities, however, are dependent upon other communities for essential services, and presumably have strong growth potentials until they reach a more balanced economy. Pending the more exhaustive study this subject deserves, the ratios suggested above would appear to indicate the type of criteria required in considering alernative urban densities.

To the extent that a dispersal policy produces independent cities, that is, cities not satellite to larger metropolitan areas, still smaller basic employment agglomerations may be desirable. Independent cities may tend to have larger ratios of service and wholesale and retail trade employment and relatively lower ratios of basic employment.

D. PLANT SIZE AND LOCATION

A separate study of trends in industrial locations and agglomeration[11] has been utilized in the preparation of this report and should be referred to for more details. Table 7 indicates that at least 13 out of 19 industry groups which built new plants in the New York area in 1945-50 showed marked trends toward dispersion,[12] that is, toward locations generally 10 to 20 miles from the metropolitan center. It suggests that a very large proportion of all new industrial plants might be located outside built-up areas without serious diseconomies. On the other hand, selected industries (in these studies particularly electrical machinery and grey steel castings) do not exhibit these tendencies and may not be readily susceptible of decentralization.

A second study dealing in detail with one of the most highly agglomerative sectors of the economy reaches somewhat similar conclusions. This is discussed in Section II. Table 8 summarizes the preliminary

[11] Isard, Walter, and Kuenne, Robert E., RECENT LOCATIONAL TENDENCIES IN U. S. INDUSTRIES, unpublished manuscript, Harvard University, 1952. Some of the data quoted from this report have not been checked.

[12] In this report, dispersion is used to signify shifts to the periphery of the metropolitan area; decentralization, shifts to other smaller cities. Diffusion and dispersal, respectively, appear to be better terms, but the terminology is adopted for the purpose of conformity with common usage.

results of an analysis of 17 four-digit steel fabricating industries. Certificates of necessity do not show any shift out of the 11 states that account for 90 per cent of the employment of these industries. However, they do show (a) dispersion, that is, shifts to the metropolitan periphery, and (b) decentralization, that is, shifts to smaller independent cities outside of existing industrial areas but still within the 11 states. The latter trend, decentralization, is more pronounced.

Table 7

Dispersion and Concentration in Postwar Plant Construction Among 19 Industry Groups in the New York Metropolitan Area, 1945-1950

No.	Industry Name	Dispersion Category: Dispersion Unqualified	Dispersion, Perhaps Qualified Once	Dispersion, Perhaps Qualified Twice	Dispersion, Perhaps Qualified Thrice	Concentration Qualified	Concentration Unqualified
20	Food Products			X			
22	Textile Products			X			
23	Apparel & Related Products (except furniture)				X		
24	Lumber & Wood Products	X					
25	Furniture & Fixtures			X			
26	Paper & Allied Products		X				
27	Printing & Publishing		X				
28	Chemical Products	X					
29	Petroleum & Coal Products	X					
30	Rubber Products		X				
31	Leather & Leather Products			X			
32	Stone, Clay, & Glass		X				
33	Primary Metal Products		X				
34	Fabricated Metal Products	X					
35	Machinery (except electrical)		X				
36	Electrical Machinery					X	
37	Transportation Equipment	X					
38	Instruments & Related Products		X				
39	Miscellaneous		X				

Source: Regional Plan Association tabulations of new-plant permits in New York area.

Table 8

Trends in Location of Manufacturing Plants Granted Certificates of Necessity as of November 1951, as Compared with 1939 Employment, for Industrial Areas, Central Cities, Other Cities, and Other Areas

	Percentage Point Gains or Losses, 17 Steel Fabricating Industries			
	Industrial Areas		Cities Outside	
Area	Cities	Other Parts	Industrial Areas	Other Locations
United States	−11.3	− .2	0.0	11.5
New England	−10.4	− 5.2	0.0	15.6
Middle Atlantic	2.9	− 9.7	−1.6	8.4
Middle West	− 2.1	6.8	− .3	− 4.4
Far West	1.9	−10.0	− .9	9.0

Source: Isard and Kuenne, *op. cit.*, Table 32.

Table 9

Qualitative Nature of Locational Patterns 15 Industries

Industry No.	Decentralization	Dispersion	Centralization Stability
3321	X		X
3323		X	
3391	X		
3411	X		
3441	X		
3494			X
3494*	X	X	
3541		X	
3543	X		
3566.3593	X		
3661.3682	X		
3717	X		
3721.3722	X		

Source: Analysis of Certificates of Necessity as of Nov. 1951. Isard and Kuenne, *op. cit.*

* Modified by omission of extreme item.

It will be noted that nationally and in two of four regions, central cities lost relatively in new plant authorization—that is, they did not receive new plants proportionally to their existing employment in the four digit industries involved. Where cities gained, the gain was small. The parts of industrial areas outside central cities and cities of 100,000 population lost slightly, although large dispersion gains are shown for two regions. Other cities gained little. Other locations, i.e., outside of cities of 100,000 population and outside of industrial areas showed very marked decentralization gains everywhere except in the Middle West.

Table 9 summarizes the results of this study. Of the 15 industries studied, 11 show marked decentralization tendencies, two show marked dispersion tendencies, and two mixed tendencies. Only two reveal trends toward centralization.

As against this evidence, there are the conclusions of a recent study of the location and size of plants built during World War II with Federal financial aid.[13] A study of 235 of these plants with a major shift employment of over 400,000 workers indicates that over half were located less than seven miles from the center of the major city in their labor market area and that two-thirds were within 10 miles of the city center. There was a minor tendency for larger plants to be located further from urban centers, but 90 per cent of all plants were inside a 20-mile radius from the downtown business district involved. The median distance was six miles. Table 10 summarizes these results.

These results confirm other studies over longer periods. From them the following conclusions may be drawn.

There is marked tendency toward the dispersion or decentralization of industry. New plants are shifting industrial location either to smaller independent cities or to the outer parts of metropolitan areas.

This trend, which is of long duration, was interrupted by the war; it is now resuming possibly at a more rapid rate. Not all industries are affected equally, but a considerable part of all industry appears to be susceptible of dispersion or decentralization.

The trend that is occurring as a result of normal economic forces is not of a scale or at a rate which will reduce industrial centralization and congestion to any marked degree in the near future. The

[13] Muncy, Dorothy A., INDUSTRIAL LAND REQUIREMENTS, Unpublished draft tables from Ph.D. Thesis, Harvard University 1952.

Table 10

Plant Size and Distance from Central Business District for 235 War Plants

Major Shift Employees	No. Plants	Cumulative Total	Distance from Central Business District in Miles			
			0-5	5-10	10-20	20 over
0-499	110	110	46	28	21	15
500-999	33	143	17	7	6	3
1000-1999	37	180	15	14	6	2
2000-4999	31	211	9	10	10	2
5000-9999	14	225	1	5	8	0
10,000-over	10	235	1	4	5	0
Total	235		89	68	56	22

Source: Muncy, *op. cit.*

existence of such a trend, however, raises the possibility that industrial decentralization in certain sections of the economy might be accelerated to a significant extent through various incentives, without introducing diseconomies or inefficiencies.

Plant Size

Table 10 also shows size of plant built during World War II with government financing. Over half of these plants employed less than 1,000 workers, and 75 per cent employed less than 2,000 workers. On the other hand, the 20 largest plants which employed over 6,000 workers each provided nearly half of the total employment of the group. All of these larger plants were within 16 miles of a city center, and 13 of them were within 10 miles of a center. It is probable that government-financed plants included most of the largest plants built during the last war and only small proportions of the smaller plants.

Data on size of industrial agglomeration are scanty. The Census of Manufactures data on plant size indicate that 82 per cent of all employees of industry worked in establishments employing less than 2,500. The 500 largest plants averaged only slightly more than this figure.[14] On the other hand, Florence suggests a higher degree of concentration in plants of larger size.[15] There must be several score compact industrial agglomerations employing over 10,000 workers.

[14] U. S. Census of Manufactures, 1947. Vol. I, Part III, Table 1, p. 97.

[15] Florence, Sargent, INVESTMENT, LOCATION, AND SIZE OF PLANT. Cambridge, 1948, p. 124.

Even where relatively small plants are involved, total employment in an industrial district or area may be very large. Major industrial districts in the largest cities may employ 50,000 workers or more. If only because of the traffic, environment, and limited expansibility of such districts, their current economic advantage may be questioned. Forces making for agglomeration *within the city* deserve intensive study.

Obviously a very large proportion of our manufacturing employment is in plants, industries, or agglomerations of 5,000 workers or less. Further research could bring out the exact magnitudes involved. It is equally clear that many industries are susceptible of decentralization in one form or another. Similarly, there will remain some industries and some plants which because of economic characteristics or size cannot be moved far from major metropoli, or may require local agglomeration of size.

E. MINIMUM DENSITIES FOR METROPOLITAN DISPERSION

The frame of reference of this report is as follows: "To develop preliminary density standards for metropolitan dispersion which would indicate the degree to which metropolitan areas might be spread out without serious losses of economic efficiency and without drastic alterations in existing patterns of employment, social organization, transportation, and municipal services."

Metropolitan areas exist and grow because they provide places for manufacturing, wholesale and retail trade, and for centers or exchange points of transportation. They also serve important cultural and social functions; they must house, feed, and service large numbers of people, and transport them to work, to stores, and to places of recreation. These functions must be accomplished in an economical way and with a minimum of inconvenience, and the metropolitan area must meet the following criteria:

(1) Provide adequate supplies of labor, that is, house sufficient numbers of workers to meet the needs of large agglomerations of industry or other employment sources.

(2) Transport labor and goods to place of manufacture at minimum time and cost.

(3) Provide essential public services at minimum cost.

(4) Provide a balance of economic activity, that is, manufacturing, trade, transportation, and other services.

(5) Permit and sustain cultural functions, schools, theatres, social organizations.

(6) Conform to the established preferences of people as to dwelling type and location.

(7) House people at costs within their means.

(8) Provide sufficient amenity to maintain morale and command loyalty to the social system.

What are the minimum density standards which will meet these criteria?

(1) Adequate labor supplies

It has been concluded that a large proportion of basic industry occurs in relatively small establishments. Single plants or agglomerations of small plants rarely require concentrations of more than 10,000 workers on one site. Such concentrations in basic industry normally require total populations of less than 50,000 persons. Even basic industry requirements of 20,000 workers can be met by populations of 100,000 people.

Table 11 shows the area necessary to accommodate the populations required by different numbers of basic workers in accordance with data presented earlier and different gross densities. The table shows that populations of approximately 100,000 people can be assembled within reasonable areas and at reasonable distances from centers at densities as low as 500 persons to the square mile. If driving times as low as 15 miles per hour are assumed, densities of 1,000 persons to the square mile would put most workers within 20 minutes of the center.

(2) Transportation time and cost

As has just been indicated, densities of 1,000 persons per mile would place virtually all workers within reasonable distances of places of employment for populations of up to 100,000 persons. Charts 1, 2, and 3 illustrate the relationship between density, area, and driving time which would obtain at various population and labor force levels. In Chart 3, 10 per cent of the available basic and total labor force is also shown to illustrate the choices available to a manufacturer who sought to recruit a limited proportion of the workers out of the total supply available.

Table 11

Areas in Square Miles at Different Densities Required to Support Industrial Complexes Employing from 1,000 to 21,000 Basic Workers

Density and Type of Development		Area in Square Miles and Radius of Development in Lineal Miles							
		Number of Basic Workers							
		1,000	3,000	6,000	9,000	12,000	15,000	18,000	21,000
		Total City Population							
		7,240	21,740	26,430	39,640	52,860	66,080	79,290	92,510
Rural Farm Area (100 persons/sq. mi.)	Sq. Mi.:	72.4	217.4	264.3	396.4	528.6	660.7	729.9	929.0
	Radius:	4.8	8.26	9.19	11.2	12.98	14.5	15.2	17.2
Rural NonFarm Area (300 per./sq. mi.)	Sq. Mi.:	24.1	72.5	88.2	132.2	176.0	220.2	264.0	308.0
	Radius:	2.77	4.8	5.3	6.5	7.5	8.42	9.18	9.91
Rural NonFarm Area (500 per./sq. mi.)	Sq. Mi.:	14.5	43.5	52.9	79.4	105.6	132.0	158.6	185.0
	Radius:	2.12	3.72	4.1	5.02	5.8	6.5	7.12	7.68
Outer Suburban (1,000 per./sq. mi.)	Sq. Mi.:	7.2	21.7	26.4	39.6	52.8	66.0	79.2	92.5
	Radius:	1.51	2.63	2.89	3.55	4.1	4.58	5.02	5.43
Suburban (2,000 per./sq. mi.)	Sq. Mi.:	3.6	10.9	13.2	19.8	26.4	33.0	39.6	46.3
	Radius:	1.06	1.87	2.05	2.51	2.9	3.24	3.55	3.84
Moderate Urban (5,000 per./sq. mi.)	Sq. Mi.:	1.45	4.3	5.3	7.9	10.6	13.2	15.8	18.5
	Radius:	.68	1.16	1.29	1.58	1.83	2.05	2.24	2.52
Dense Urban (10,000 per./sq. mi.)	Sq. Mi.:	.7	2.1	2.6	3.9	5.2	6.6	7.9	9.2
	Radius:	.47	.81	.91	1.11	1.28	1.45	1.58	1.74

CHART 1

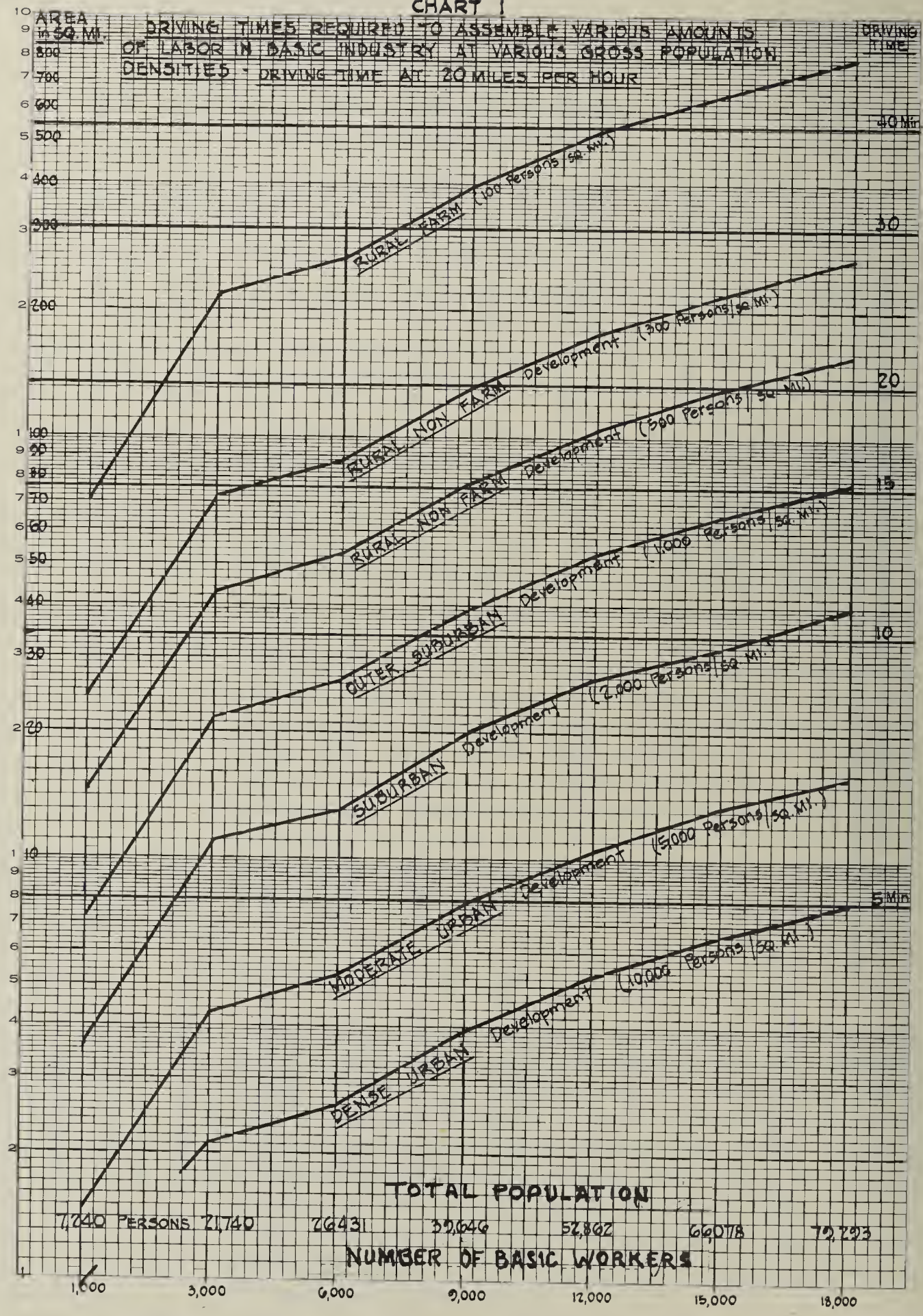

AREA in SQ. MI.
DRIVING TIMES REQUIRED TO ASSEMBLE VARIOUS AMOUNTS OF LABOR IN BASIC INDUSTRY AT VARIOUS GROSS POPULATION DENSITIES - DRIVING TIME AT 20 MILES PER HOUR
DRIVING TIME
40 Min.
30
20
15
10
5 Min
RURAL FARM (100 Persons/Sq. Mi.)
RURAL NON FARM Development (300 Persons/Sq. Mi.)
RURAL NON FARM Development (500 Persons/Sq. Mi.)
OUTER SUBURBAN Development (1,000 Persons/Sq. Mi.)
SUBURBAN Development (2,000 Persons/Sq. Mi.)
MODERATE URBAN Development (5,000 Persons/Sq. Mi.)
DENSE URBAN Development (10,000 Persons/Sq. Mi.)
TOTAL POPULATION
7,240 Persons 21,740 26431 32,646 52,862 66,078 72,293
NUMBER OF BASIC WORKERS
1,000 3,000 6,000 9,000 12,000 15,000 18,000

CHART 2

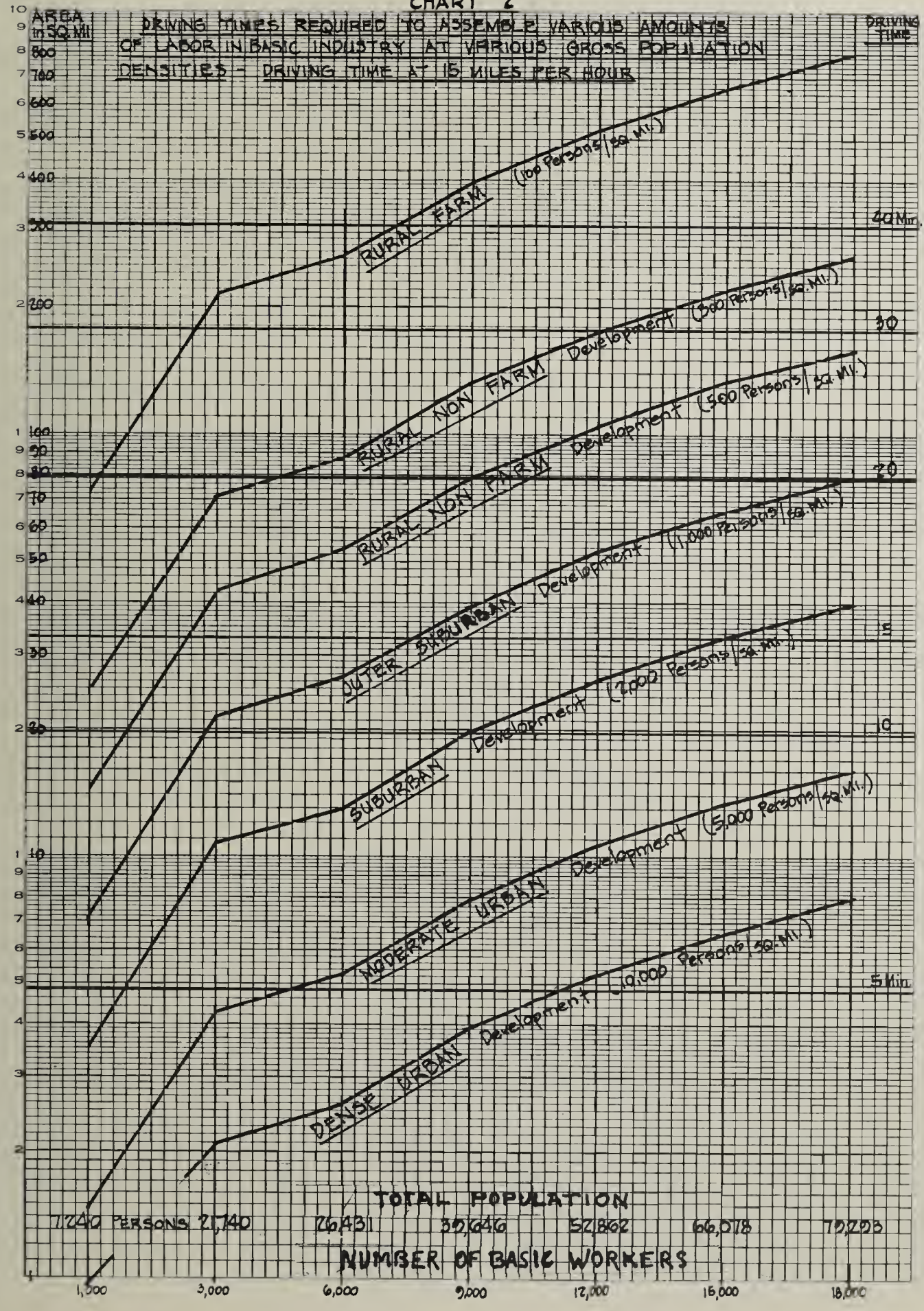

AREA in SQ. MI
DRIVING TIMES REQUIRED TO ASSEMBLE VARIOUS AMOUNTS OF LABOR IN BASIC INDUSTRY AT VARIOUS GROSS POPULATION DENSITIES - DRIVING TIME AT 15 MILES PER HOUR
DRIVING TIME
RURAL FARM (100 Persons/Sq. Mi.)
RURAL NON FARM Development (500 Persons/Sq. Mi.)
OUTER SUBURBAN Development (2,000 Persons/Sq. Mi.)
SUBURBAN Development (5,000 Persons/Sq. Mi.)
MODERATE URBAN Development (10,000 Persons/Sq. Mi.)
DENSE URBAN Development
40 Min.
30
20
15
10
5 Min.
TOTAL POPULATION
7,240 PERSONS 21,740 36,231 50,646 57,862 66,078 72,293
NUMBER OF BASIC WORKERS
1,500 3,000 6,000 9,000 12,000 15,000 18,000

CHART 3

DRIVING TIMES REQUIRED TO ASSEMBLE VARIOUS AMOUNTS OF LABOR IN BASIC INDUSTRIES AT VARIOUS GROSS POPULATION DENSITIES. DRIVING TIME AT 20 MILES PER HOUR

AREA IN SQ. MI.

DRIVING TIME

40 Min.

30

20

15

10

5 Min.

RURAL FARM (400 Persons/Sq. Mi.)

RURAL NON FARM (300 Persons/Sq. Mi.)

RURAL NON FARM (500 Persons/Sq. Mi.)

OUTER SUBURBAN (1,000 Persons/Sq. Mi.)

SUBURBAN (3,000 Persons/Sq. Mi.)

MODERATE URBAN (5,000 Persons/Sq. Mi.)

DENSE URBAN (10,000 Persons/Sq. Mi.)

A - TOTAL CITY POPULATION
B - TOTAL NO. EMPLOYED WORKERS
C - 10% TOTAL NO. EMPLOYED WORKERS
D - 10% TOTAL NO. BASIC WORKERS

7,240 - A	21,740	26,43	30,646	52,867	66,078	70,293 - A	92500
2,000 - B	8,110	10,430	15,020	20,820	26,040	31,180 - B	36,420
870 - C	811	1,043	1,562	2,082	2,604	3,118 - C	3,642
300 - D	300	600	900	1,200	1,500	1,800 - D	2,100

Cost of transportation, however, requires higher densities. Even under optimistic assumptions densities of 2,000 persons are required to maintain bus services necessary for secondary workers, shopping, and as a standby service essential even where primary workers ordinarily drive. Public transit service, in any event, is far cheaper than individual automobile transportation. To maintain high frequency service, densities of 5,000 persons to the mile would be desirable. On the other hand, it is doubtful whether a high-efficiency rail transit system will be built in the future to serve densities even as high as 10,000 persons to the square mile. Economy of transit would therefore dictate minimums of 2,000 to 5,000 persons to the square mile.

(3) Essential public services at low cost

Essential public services, sewer, water, police and fire protection, and the like are functions of both density and size of population.[16] While there appears to be no optimum size or density applicable to all situations, there appears to be some agreement that cities in the size range 20,000 to 100,000 population can generally offer a reasonably complete range of services at costs below those of smaller or larger cities.[17]

Very low or very high densities also appear to increase municipal service costs. At very low densities, some services are unnecessary (sewers) but other services such as water and schools are more costly. At very high densities a full range of services is necessary, and some costs, police and fire for instance, rise sharply. Densities in the range of 200 to 5,000 persons per square mile appear to be most economical both in services required and in unit cost of providing them. Compactness of development at any density level may be as important an element in cost as density.[18]

(4) Provide a balance of economic activity

Balanced economic activity appears to be more a function of size than of density. Cities of small size may find it impossible

[16] Duncan, Otis D., Optimum Size of Cities, in Reader in Urban Sociology, Paul Hatt and Albert Reiss, Sr., Editors. Glencoe, Free Press, 1951, pp. 637-639.

[17] Schussheim, Morton J., The Cost of Municipal Services in Residential Areas, unpublished Ph.D. Thesis, Harvard, 1952, Part III.

[18] *Ibid.*, Part III.

to sustain adequate retail trade services, sufficient specialization in other services, or an adequate range of job opportunities in industry.[19] These problems may arise in communities of 20,000 or below, but a very wide range of economic activity becomes possible in cities of 30,000 to 50,000. Since such sizes can be reached with densities as low as 500 persons to the square mile, only quick and economical access to services and facilities remains as a criterion. This is largely a matter of transportation, and suggests minimum densities of 1,000 with preference for densities of 2,000 to 5,000.

(5) Cultural functions

Duncan cites population sizes of 25,000 to 50,000 as necessary to sustain certain cultural functions and social organizations. Density is again a consideration, chiefly from the standpoint of access; densities of 2,000 to 5,000 per square mile are suggested.

It may be contended that certain cultural functions, such as theaters, art museums, and specialized service organizations and clubs, require large concentrations of population, high densities, and central locations. If this is true, such places could nevertheless be available within areas whose gross population density did not exceed 5,000 persons to the square mile. In the main, however, highly specialized social and cultural functions will locate only in existing central cities and would continue to serve newly developed satellite areas.

(6) Preference as to dwelling type and location

In Table 3, the mixtures of dwelling types currently produced by the building industry were set forth. Presumably these reflect to some degree the preferences of the American people. Virtually all of the evidence suggests that well over half of the American people prefer single homes and suburban, that is, low-density locations (2,500 to 6,700 persons per square mile). These preferences may be the decisive ones in future urban growth.[20]

[19] Duncan, *op. cit.*, pp. 641, 642.

[20] Very convincing evidence on this point is presented as the result of housing choices of employees at Oak Ridge, Tenn. cf. STATEMENT ON PRELIMINARY RESULTS FROM MAIL QUESTIONNAIRES ON HOME OWNERSHIP AND SELF GOVERNMENT AT OAK RIDGE Bureau of the Census, unpublished, 1952.

(7) Housing at economic costs

It is not now possible to provide decent new housing for a large proportion of American families at prices they can afford to pay. To the extent that new housing is made available to families in the middle and lower income groups, governmental assistance in some form is and will be required. In order to minimize such costs dwelling types and densities of the most economical kind would be required. These are single homes on small lots, row and semi-detached houses, and apartments. Theoretically, the high-density mix of Table 3, the mix characteristic of East Coast cities, approaches this requirement. In view of the fact that this pattern runs counter to prevailing public preference, something between it and the present pattern, which largely serves families in upper income groups, must be adopted. These criteria would best be met with the moderate-density mix characteristic of the 1920's and with densities of 2,800 to 7,800 persons to the square mile.

(8) Amenity

Amenity may be largely a matter of design, but it is also affected by density. Presumably American people desire ready access to the country-side and open spaces. Presumably also urban Americans like urban settings, busy streets, masses of buildings, and the pleasures of the city. Both are required. Within the limits of gross density here discussed both could be available. Gross densities of 2,000 to 7,000 persons per square mile are susceptible of high concentrations of net density in accordance with popular preference and economic advantage. All of the gross densities permit substanial areas of open land. To the extent that density is a factor in amenity, densities of 1,000 to the high-density mix level of 8,000 would meet amenity requirements.

Table 12 summarizes these judgments.

Reducing Existing Concentration

A remaining question, one not treated elsewhere in this report, is "Could existing metropolitan areas be brought down to these densities?" Obviously a reduction of the density of existing metropolitan areas to these minimum levels would involve large expenditures, long periods of time, and readjustments in many spheres. Disregarding

Table 12

Summary Scores of Minimum Metropolitan Dispersal Standards[a]

Criteria	Minimum Densities Per Gross Square Mile 10,000	5,000	2,000	1,000	500
Labor Force	4	4	3	1	0
Transportation	4	4	3	1	0
Public Services	2	4	4	2	1
Balanced Economy	4	4	3	1	0
Cultural Functions	4	4	4	2	1
Housing Preferences[c]	0	4	4	2	1
Housing Economy[d]	4	4	2	1	0
Amenity	2	3	4	2	1
Total Score	24[b]	31	27	12	4[b]
Best Cases		x	x		

[a]Basis of score: Reject = 0
Indifferent = 1
Acceptable = 2
Preferred = 3
Best = 4

[b]Includes reject rating.

[c]Actual Range is 2,500 to 5,500.

[d]Actual Range is 2,500 to 7,100.

---

these problems, it would be theoretically possible to redistribute the population of any given metropolitan area at lower densities and within manageable distances. At 2,000 persons to the square mile the population of Chicago could be accommodated within something like a 30-mile radius; at 5,000 persons to the square mile, within a 15-mile radius.

Table 13 illustrates these relationships for cities of various size and density; the assumption is made that the city occupies only two-thirds of the arc of its radius; as in the case of Chicago, Boston, and other cities, it adjoins a body of water which reduces usable area. Six cases in the lower densities and higher populations appear questionable. All other cases provide manageable driving times on reasonable design assumptions. These standards, therefore, appear feasible for all except the half dozen largest cities in the country. In those cities higher concentrations over limited areas may be required if the existing concentration of central functions persists.

Table 13

Number of Square Miles and Radius in Lineal Miles for Populations of Metropolitan Areas Uniformly Distributed at Different Densities[a]

Total Population of Metropolitan Areas		Density in Persons per Gross Square Mile 10,000	5,000	2,000	1,000	500
50,000	Sq. Miles	5.0	10.0	25.0	50.0	100.0
	Radius[b]	1.54	2.18	3.54	4.85	6.92
100,000	Sq. Miles	10.0	20.0	50.0	100.0	200.0
	Radius	2.18	3.09	4.88	6.92	9.79
500,000	Sq. Miles	50.0	100.0	250.0	500.0	1000.0
	Radius	4.88	6.92	10.9	15.45	21.85
1,000,000	Sq. Miles	100.0	200.0	500.0	1000.0	2000.0
	Radius	6.92	9.79	15.45	21.85	30.9
2,000,000	Sq. Miles	200.0	400.0	1000.0	2000.0	4000.0
	Radius	9.79	13.8	21.85	30.9	43.7

[a]One-third of a complete circle drawn around metropolitan areas considered to be water.

[b]Radius of the 240-degree arc which will include the stated area.

CONCLUSIONS

(1) The vital functions of American metropolitan areas could be performed without serious dislocation of existing economic, social, or governmental functions if the future development of such areas was maintained at densities of from 5,000 to 2,000 persons per square mile.

(2) These densities correspond closely to those being produced in the peripheral development areas of modern cities. They need only be maintained thereafter.

(3) With time and resources, it would be possible to accommodate populations of up to 2,000,000 persons within the 2,000 to 5,000 population density range.

(4) A maximum standard of density for metropolitan dispersion could be established at 5,000 persons per gross square mile. A minimum standard of lower than 2,000 persons per gross square mile appears to be inadvisable.

F. OPTIMUM STANDARDS FOR METROPOLITAN DISPERSION

The second frame of reference of this report is as follows: "Standards should also indicate the nature of optimum standards of metropolitan dispersion, using the same criteria, and cover such matters as space between communities and density of population and structures within communities." The criteria were "without serious losses of economic efficiency and without drastic alterations in existing patterns of employment, social organization, transportation and municipal services.

In the preceding section certain criteria were established to test minimum densities for metropolitan dispersion. It was pointed out that some of the criteria enumerated were functions of size rather than density and were criteria for density only in so far as density affected travel time and cost. The larger metropolitan areas, those of over 500,000 population, perform specialized economic and other functions which smaller cities usually do not or cannot perform. They provide centers of managerial, administrative, and financial control for large regions; serve as foci of transportation and communication; support very specialized professional and technical services, specialized wholesale and retail services, specialized cultural and social functions; and provide markets and labor pools of the largest size.

All of these specialized functions are found only in the largest metropolitan areas, areas generally characterized by high population densities and relatively compact development over considerable distances. These latter aspects of large metropolitan areas conflict with other requirements of cities: ease and speed of access to employment, economy of transportation, economy of municipal services, the preference for single homes, and amenity. As a result, although metropolitan areas serve vital economic functions, and continue to grow, they are criticized for traffic delays, high costs, congestion, overcrowding, etc.

To perform the vital functions of large metropolitan areas, while minimizing time, cost and inconvenience, the density and spacing of metropolitan areas must meet the following criteria:

(1) The area must permit large aggregate employments, 200,000 persons and above, and concentrations of as many as 30,000 workers in single plants or compact agglomerations of plants.

(2) The journey to work should not exceed 30 minutes for 75 per cent of workers, with no more than 10 to 20 minutes for 60 per cent of the labor force.

(3) Single concentrations of population should consist, to the maximum possible extent, of compact communities of 20,000 to 70,000 each, that is, of cities with the lowest public service requirements and the lowest unit operating costs.

(4) A complete range of employment opportunities and economic services should be available within daily commuting distances. Daily commuting distance is assumed to be 30 miles or less.

(5) A complete range of cultural and social functions and services should be available within daily commuting distance.

(6) Approximately 60 per cent of the population should be able to live in single detached homes with a wide range of lot sizes, the balance in row and semi-detached houses, and garden apartments but with sufficient elevator apartments to meet market demands for this type.

(7) Approximately 60 per cent of all employees should be able to live in the community in which they work.

(8) Dwelling types and standards should permit maximum economy in construction and operating costs, operating costs including debt service, utilities, municipal services, and travel to work.

(9) Amenity, as reflected in open space for public and private use, should be as great as possible.

These criteria apply to metropolitan areas as peacetime centers of population and employment. They suggest the necessity for a central core and satellite pattern for metropolitan areas — as long recommended by professional city planners. This pattern would have the following characteristics:

(1) The central or core area would contain only those economic functions whose specialized character required central location, particularly managerial, financial, specialized wholesaling and retailing, cultural, educational and social functions; specialized professional and technical services; and transportation termini and the service functions necessary to maintain these. The core area would be surrounded by residential areas needed to provide employees for central functions.

(2) Satellite communities would contain most manufacturing functions and those specialized functions for the metropolitan

area not requiring central locations. Each satellite would provide retail stores offering all general merchandise lines except specialized lines. All daily and most weekly shopping needs could be met by the satellite itself. The satellite would provide all but specialized services for itself. It would accommodate most of its own employees in residential locations reasonably close to places of work, would draw on other satellites for a small proportion of its workers, and would provide some labor for specialized employment in other nearby satellites.

(3) The size of satellites would vary depending upon their economic functions. Those having very large agglomerations of industry or employment would be larger than others and would be nuclei for sub-clusters of other satellites.

(4) The density of satellites would conform to the preferences of the population, the transportation means available, and the employment aggregations served.

(5) The spacing of satellites, in some generally radial pattern around the core city, would be that minimum required to preserve some open country between them, to provide room for expansion of each, to preserve the identity of each, and to permit reasonably rapid daily commuting between satellites and the central city on the part of those required to commute.

Existing metropolitan areas conform rather crudely to this pattern.[21] Both classical statements in city planning[22] and recent and progressive master plans for major metropoli describe a similar arrangement.[23] This theory of metropolitan structure has never been seriously challenged.

It is not necessary to consider here the specific design or internal arrangement of satellite communities. Satellites, as used here, could be either (a) balanced communities containing residential, industrial, and commercial areas within their developed boundaries; or (b) functionally nucleated developments consisting of compact residential communities, separate industrial districts, and separate commercial centers. The former, the classical notion of the satellite town of city planning literature, has some advantages from a purely technical standpoint. The latter may

[21] *Cf.* Bogue, Donald, THE STRUCTURE OF THE METROPOLITAN COMMUNITY, University of Michigan, 1949,

[22] *Cf.* Howard, Ebenezer, GARDEN CITIES OF TOMORROW, London, 1946; Geddes, Patrick. CITIES IN EVOLUTION, London, 1914.

[23] *Cf.* Abercrombie, Sir Patrick, GREATER LONDON PLAN, London, 1941.

prove to be the more common pattern in American cities. From the standpoint of this report the only major difference between the two would be the higher transportation cost involved in functionally nucleated development.

To the extent that considerations of defense and vulnerability enter into the planning of metropolitan areas, *five* additional criteria are required.

(1) The size of any satellite and its industrial base must be such that together they do not constitute a target worthy of attack with atomic bombs. The assumption is made that cities of 50,000 or over may become, if they are not now, target worthy in this sense.

(2) The spacing of satellite cities must be such that the satellites will not be destroyed if the core city is attacked, that adjoining satellites will not be destroyed by attack on any one of them, and such as to reduce substantially the probability that any satellite will be destroyed as a result of errors in bombings aimed at core cities. We do not presume to guess what these distances might require, but official public statements indicate them to be of the order of 10 miles.

(3) The density of satellites should be low enough to minimize destruction in the event of attack, prevent fire storms, and permit rapid salvage operations.

(4) Functional interdependence of satellites upon the core city and each other should be reduced to the maximum possible extent, so as to reduce or eliminate the impairment of one satellite as a result of the destruction of another. Satellite dependance upon a central city for electric power, water, fuel, food, transportation, or labor would be a major weakness in the pattern.

(5) All of the above criteria must be kept within the limits of public acceptance and economic efficiency. Serious losses of economic efficiency for peacetime purposes should be avoided.

Alternative spacings and densities of satellite cities are presented in the charts and tables which follow. For purposes of this study the size range of satellites adopted has been 50,000 to 20,000 people. Similar relationships would obtain where smaller satellites were possible. The density ranges are those selected as feasible, with slightly higher and lower densities presented to illustrate their effect. Three spacings between

towns have been adopted. These are 3, 5, and 10 miles between the peripheries of town areas. These spacings correspond to average distances of 8, 10, and 15 miles between the centers of satellites.

In all cases it should be noted that the population between satellites has not been shown on the charts. This population at rural nonfarm or small farm densities of 200 persons to the square mile (average farm or lot size = 10 acres) provides a very considerable population resource. A 10-mile radius around a town five miles in radius, for example, would accommodate a population of 45,000 persons and a potential labor force of 13,000 to 18,000 people. For purposes of rough estimation this number might be added to the urban labor force available at any alternating point, but not at adjoining points.

Charts 4 through 9 show the normal labor force available (the total normal number employed in all occupations and at all points within the given travel time) for each satellite, for three spacings of towns, for five densities of towns, and for two assumed travel times. The labor force available at any point is assumed to consist of the entire resident labor supply and 40 per cent of the supply of adjoining satellites within the stated travel-time distance. For this reason the labor supplies indicated are not available at all points, but are available at any point on alternating radials. To the extent that the full force were utilized at any single point, the labor in the surrounding towns would be reduced by 40 per cent of the number of workers resident therein. The potential supply in inner-ring satellites includes a portion of the supply from the core city, calculated on a consistent basis.

The charts reveal that labor supplies adequate to support basic industry plants or agglomerations of 20,000 workers or more are available in the inner ring of satellites only for the higher densities or the lower spacings of towns. With driving time at 30 minutes, adequate supplies are available at all densities for spacings of 3.2 and 5 miles and at densities of over 2,000 to the square mile where spacings are 10 miles. At 20 minutes, the preferred driving time and one which would permit good public transit service, 20,000 basic workers would be available only at densities of approximately 2,000 or more for spacings of 3.2, 5, and 10 miles. In the latter case more than half of the labor supply computed is from the rural nonfarm area surrounding the towns; no labor is recruited from adjoining towns.

For this reason, it is concluded that where spacings of more than 10 miles between the peripheries of satellites are considered necessary, and where densities are lower than 2,000, adjoining rural nonfarm populations must be considered an essential part of the urban labor

CHART 4

Schematic Diagram of

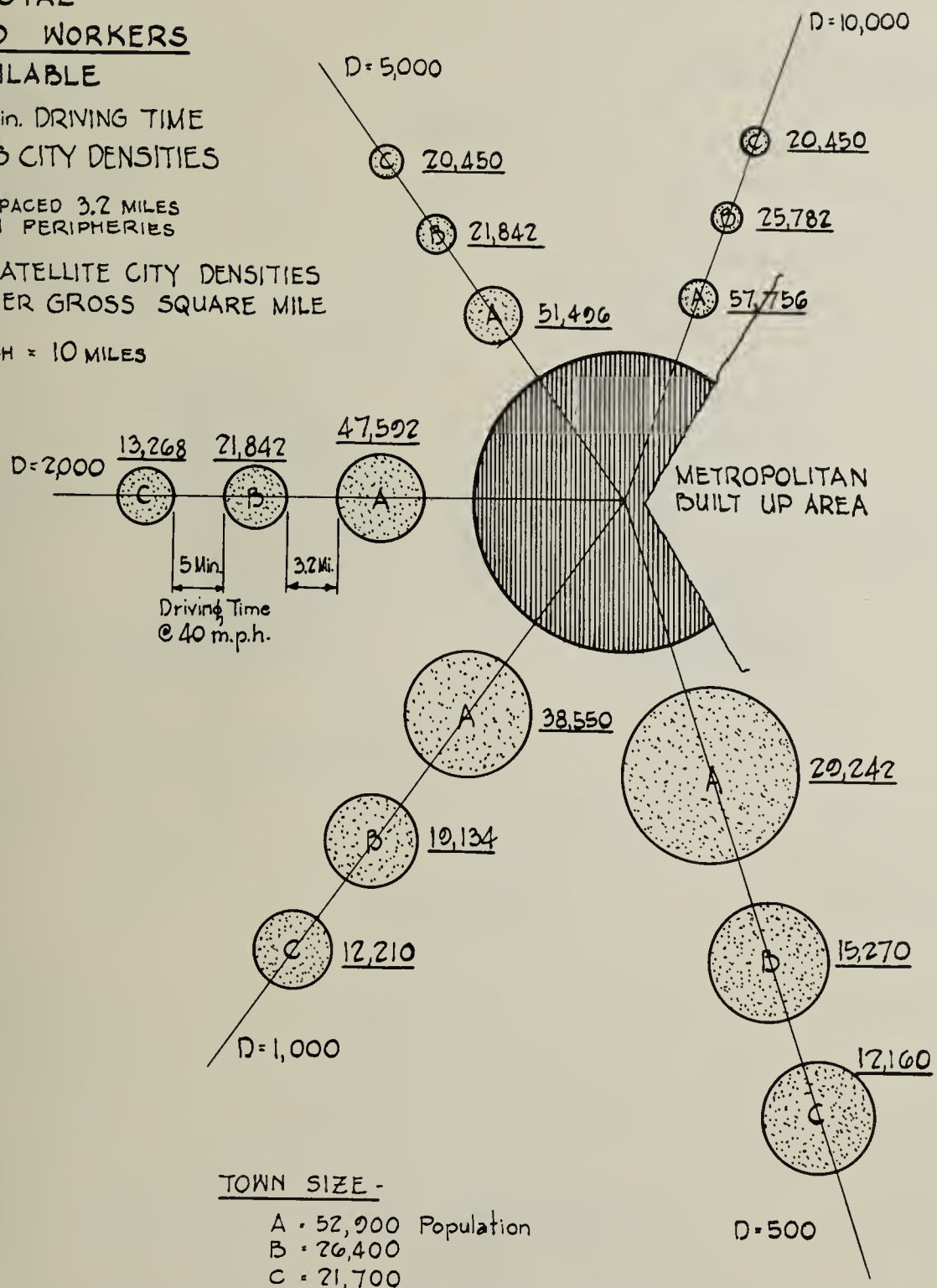
TOTAL EMPLOYED WORKERS AVAILABLE

WITHIN 30 Min. DRIVING TIME
AT VARIOUS CITY DENSITIES

IN TOWNS SPACED 3.2 MILES
BETWEEN PERIPHERIES

D = SATELLITE CITY DENSITIES
PER GROSS SQUARE MILE

Scale: 1 INCH = 10 MILES



TOWN SIZE -

A = 52,900 Population
B = 26,400
C = 21,700

Resident Labor Force in Suburban Area
is 30,360 employed workers per radial.

NOTE

Driving Time Between Peripheries @ 40 m.p.h.
" " Within Cities @ 20 m.p.h.
Industry assumed to be at center of Town

CHART 5

Schematic Diagram of

TOTAL

EMPLOYED WORKERS

AVAILABLE

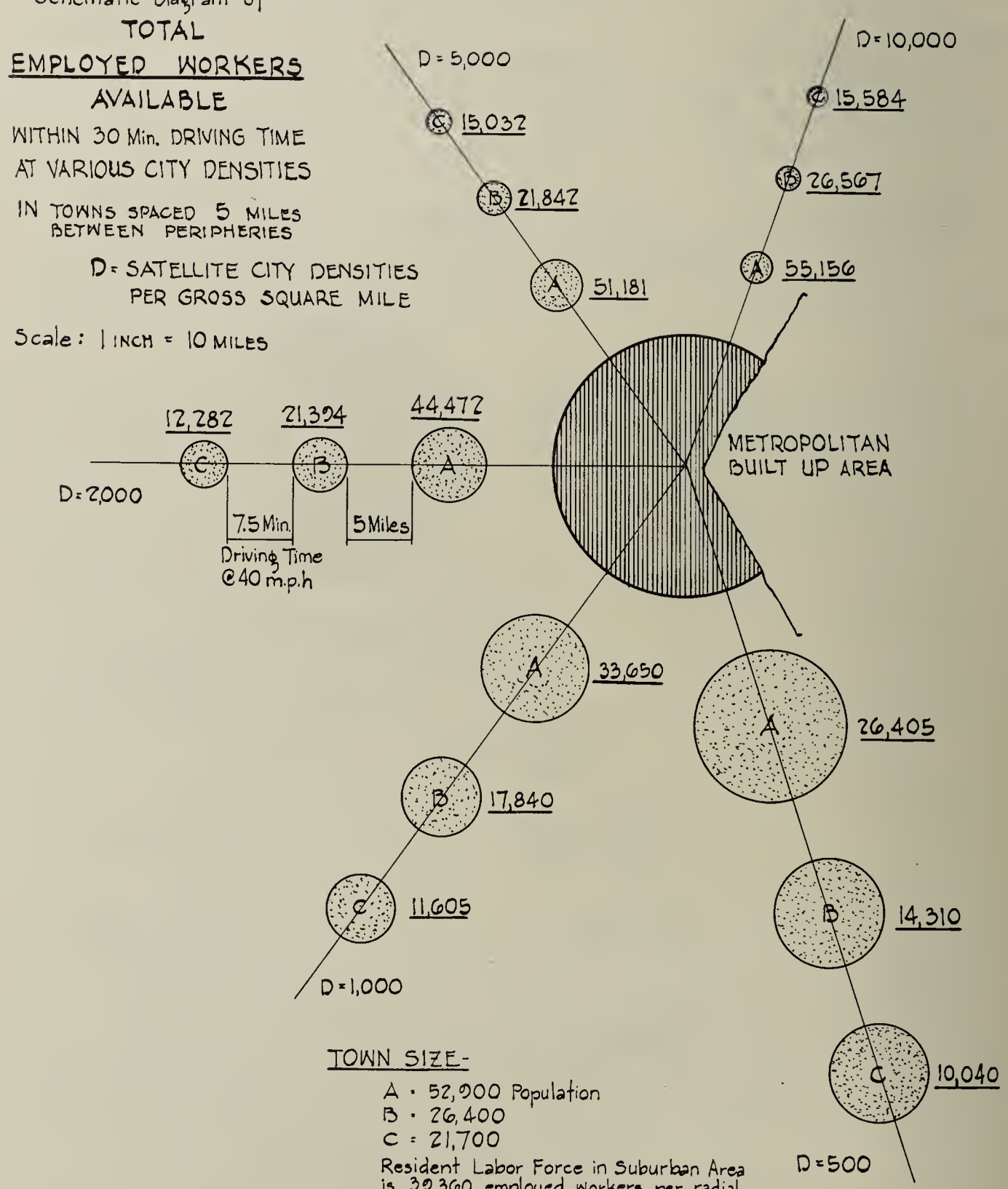
WITHIN 30 Min. DRIVING TIME

AT VARIOUS CITY DENSITIES

IN TOWNS SPACED 5 MILES BETWEEN PERIPHERIES

D = SATELLITE CITY DENSITIES PER GROSS SQUARE MILE

Scale: 1 INCH = 10 MILES



TOWN SIZE-

A - 52,900 Population
B - 26,400
C - 21,700

Resident Labor Force in Suburban Area is 30,360 employed workers per radial.

NOTE

Driving Time Between Peripheries @ 40 m.p.h.
" " Within Cities @ 20 m.p.h.
Industry assumed to be at center of Town

CHART 6

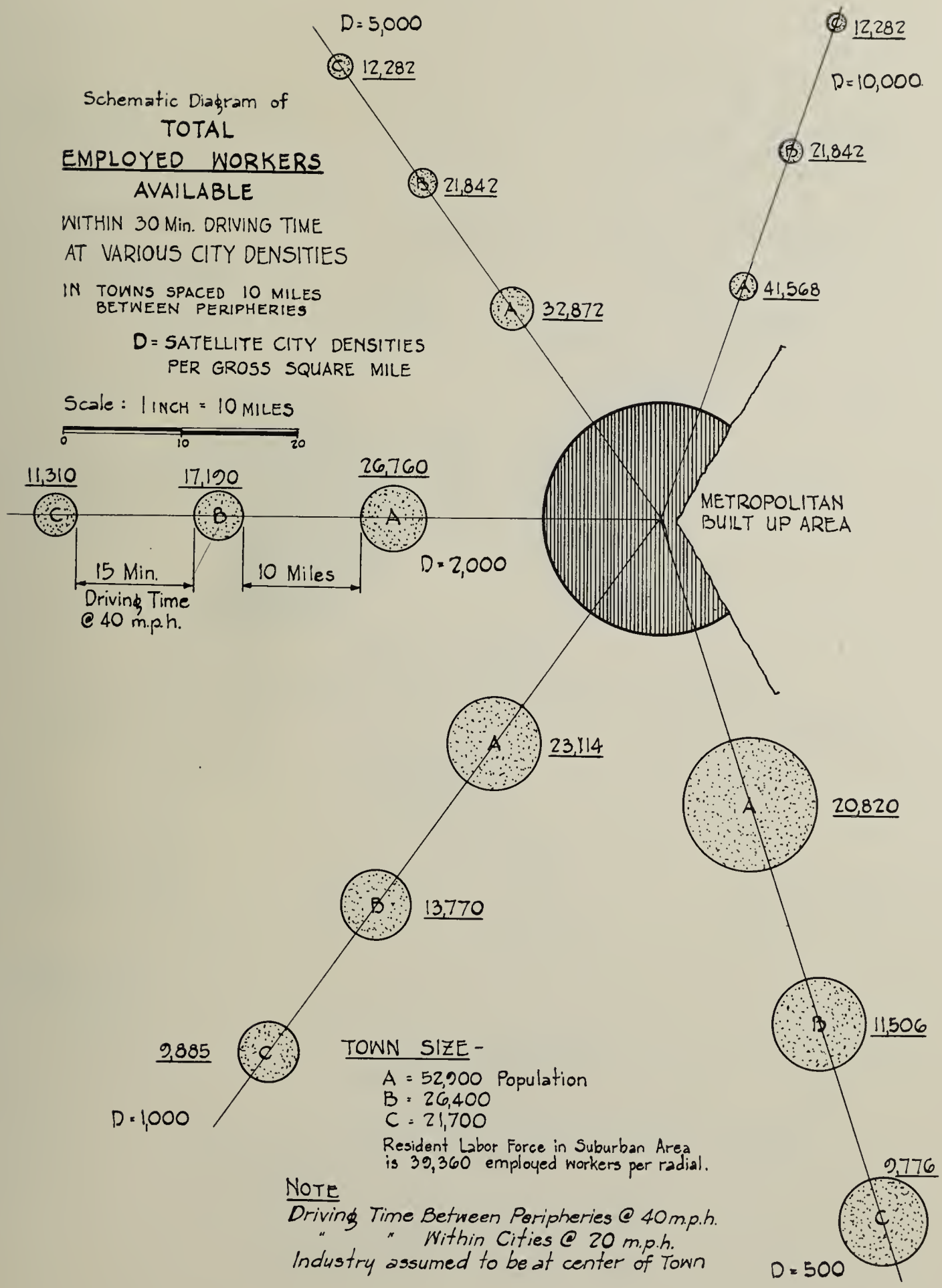

Schematic Diagram of
TOTAL
EMPLOYED WORKERS
AVAILABLE
WITHIN 30 Min. DRIVING TIME
AT VARIOUS CITY DENSITIES
IN TOWNS SPACED 10 MILES
BETWEEN PERIPHERIES
D = SATELLITE CITY DENSITIES
PER GROSS SQUARE MILE
Scale : 1 INCH = 10 MILES
0
10
20
11,310
17,190
26,760
C
B
A
15 Min.
Driving Time
@ 40 m.p.h.
10 Miles
D = 2,000
METROPOLITAN
BUILT UP AREA
D = 5,000
C 12,282
B 21,842
A 32,872
C 12,282
D = 10,000
B 21,842
A 41,568
A 23,114
B 13,770
2,885
C
D = 1,000
A 20,820
B 11,506
2,776
C
D = 500
TOWN SIZE -
A = 52,900 Population
B = 26,400
C = 21,700
Resident Labor Force in Suburban Area
is 30,360 employed workers per radial.
NOTE
Driving Time Between Peripheries @ 40 m.p.h.
" " Within Cities @ 20 m.p.h.
Industry assumed to be at center of Town

CHART 7

Schematic Diagram of

TOTAL

EMPLOYED WORKERS

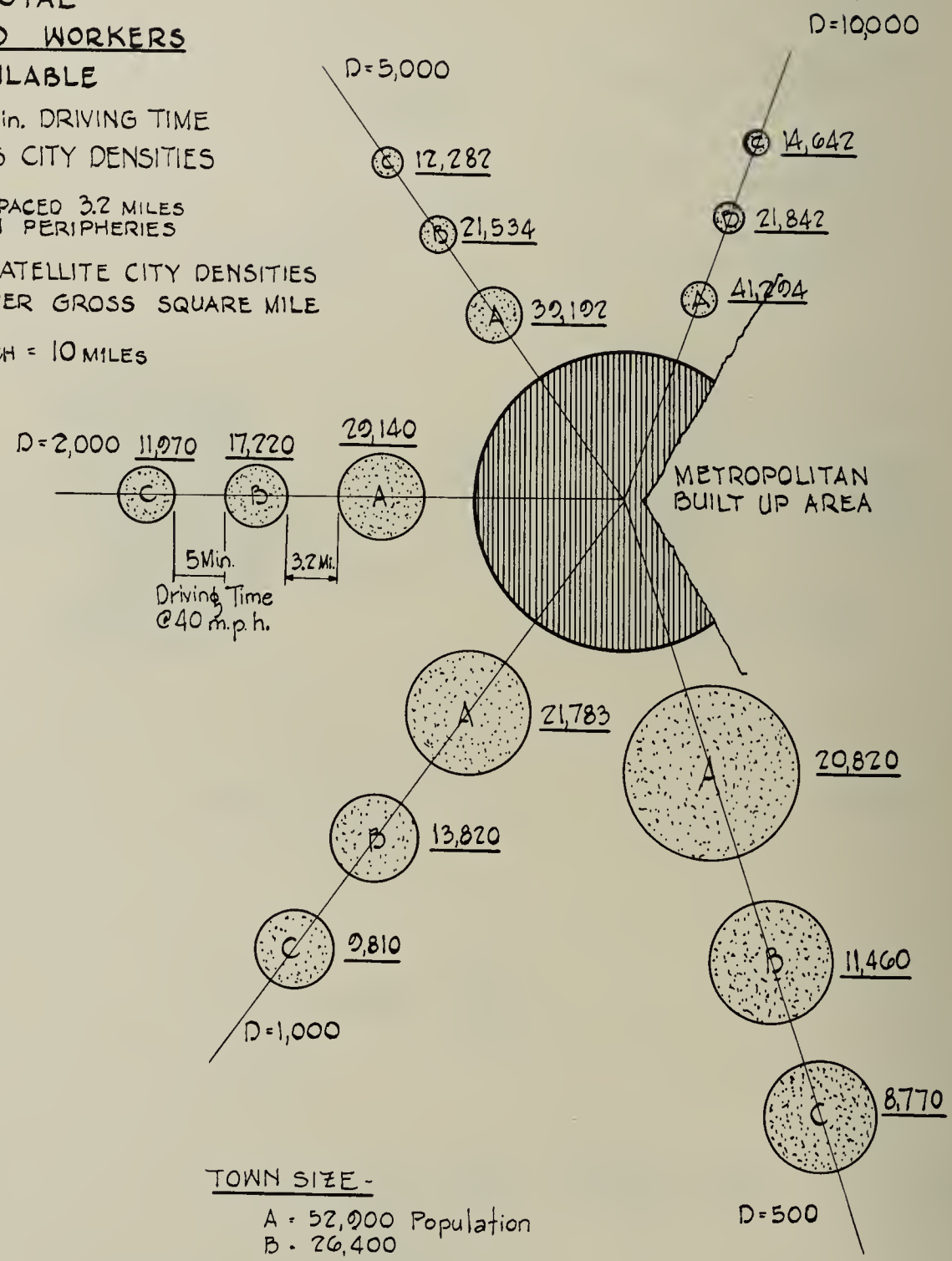
AVAILABLE

WITHIN 20 Min. DRIVING TIME
AT VARIOUS CITY DENSITIES

IN TOWNS SPACED 3.2 MILES
BETWEEN PERIPHERIES

D = SATELLITE CITY DENSITIES
PER GROSS SQUARE MILE

Scale : 1 INCH = 10 MILES



TOWN SIZE -

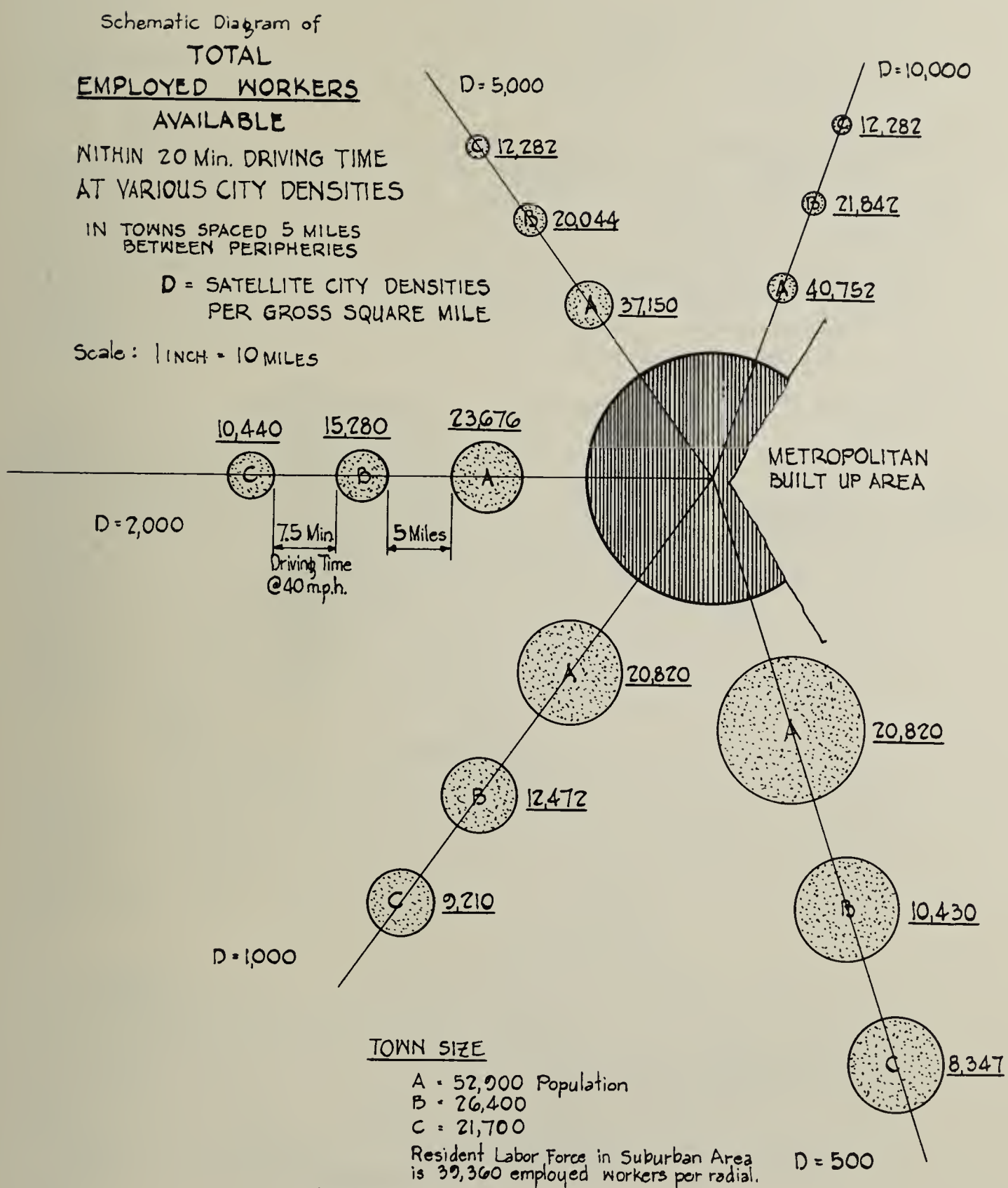
A = 52,000 Population
B = 26,400
C = 21,700

Resident Labor Force in Suburban Area is 39,360 employed workers per radial.

NOTE

Driving Time Between Peripheries @ 40 m.p.h.
" " Within Cities @ 20 m.p.h.
Industry assumed to be at center of Town

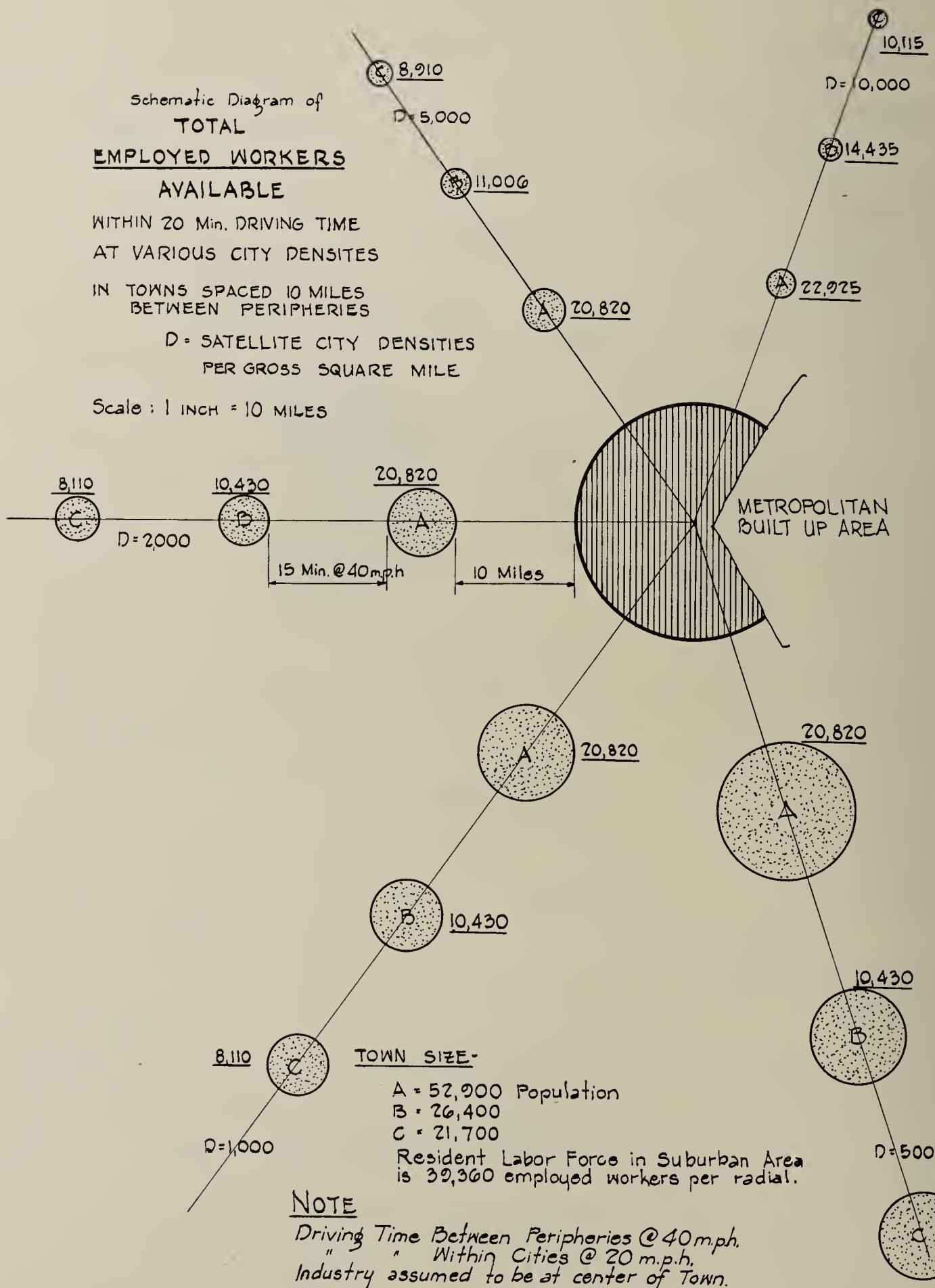
CHART 8



NOTE

Driving Time Between Peripheries @ 40 m.p.h.
" " Within Cities @ 20 m.p.h.
Industry assumed to be at center of Town

CHART 9



NOTE

Driving Time Between Peripheries @ 40 m.p.h.
" " Within Cities @ 20 m.p.h.
Industry assumed to be at center of Town.

force. Towns so spaced may be treated as independent towns for this purpose, although special travel, highway or plant locations might be developed, particularly at 30-minute travel times, to permit such towns to be included in a metropolitan net.

The charts also indicate that much larger labor supplies become available at town densities above those now being built in the United States. Since such concentrations of labor do not appear to be necessary in the future, or feasible within the present preferences of the American people, they are not recommended. Higher densities make spacing above the 10-mile limit feasible, and would encourage use of public transit facilities which are an adverse factor for greater spacing at lower densities.

Table 14 summarizes the labor supply available at various points in the satellite pattern. If it is assumed that half of all workers can be employed in basic industry, then all cases shown on the table will be satisfactory where employment in single plants or industrial districts does not exceed 10,000 workers. Where concentrations of 20,000 are required, densities of 2,000 persons to the square mile are required, but spacing can be as much as 10 miles. Where concentrations of 25,000 workers are required, densities of 5,000 or driving times of 30 minutes become necessary and 10-mile spacings become difficult. Beyond 10-mile spacings labor supplies fall to, for practical purposes, those of independent cities.

Chart 10 illustrates the increases in labor force made available by the introduction of sub-satellites off of major radials. (Compare with Chart 5.) In the higher densities and lower spacings the increases are marked for outer satellites, with no increases for inner satellites and lower densities. Chart 10 illustrates the theoretical losses in labor force arising from tangential radials.

Charts 11 and 12 show the effects resulting from functionally nucleated development and compare tangential highways with limited-access highways penetrating satellite centers. At D = 2,000, the chart reveals that labor forces could be available on the functional pattern in quantities equal to or greater than those available on the normal satellite pattern. This is roughly true for both highway patterns, but all other things being equal, the freeway pattern will raise labor supplies at 10-miles distance by approximately 50 per cent.

It is obvious that the feasibility of the satellite pattern is in varying degrees dependent upon the same elements of cost, preference, service, travel time and amenity as are single cities. A well-developed

Table 14

Maximum Labor Supply Available at Points in Satellite Pattern at Various Densities, Town Spacings, and Driving Times

Distance Between Town Peripheries	Density	Labor Supply at Peak Point Along Radials*	
		20-min. Driving Time	30-min. Driving Time
10 miles	10,000	50,025	86,470
"	5,000	44,950	77,670
"	2,000	39,620	71,410
"	1,000	33,600	65,510
"	500	24,160	52,570
5 miles	10,000	62,150	91,050
"	5,000	57,300	87,480
"	2,000	39,820	81,170
"	1,000	33,600	67,650
"	500	24,160	54,820
3.2 miles	10,000	61,270	93,550
"	5,000	57,820	87,740
"	2,000	44,340	83,590
"	1,000	34,560	72,000
"	500	24,160	56,250

* Includes all employed persons in inner satellite, 15,760 workers from outer portion of central city and 40 per cent of employed workers in other satellites where such workers are within stated travel times, and an assumed proportion (30 per cent) of the rural nonfarm population.

system of ring and radial highways would increase the availability of labor, as would an efficient public transit system. This type of consideration need not be treated in detail here. It is also clear that the core city could obtain adequate labor supplies from the satellites only at higher densities with spacings of less than 10 miles.

Table 15 summarizes the application of the peacetime and defense criteria to the satellite pattern for various densities and spacings. While subjective factors enter into ratings, the table does attempt to assign weights to each criterion. In certain cases, such as building type, reject ratings have been assigned. The table indicates advantages for densities of 2,000 to 5,000 persons to the square mile, with some advantages to slightly higher densities if they were buildable and acceptable. The 10,000-density ratings are weighted by factors which apply chiefly in the 7,000 to 8,000 density range. The table indicates advantages on peacetime scores for spacings of three and five miles which tend to outweigh the defense scores for greater spacing.

CHART 10

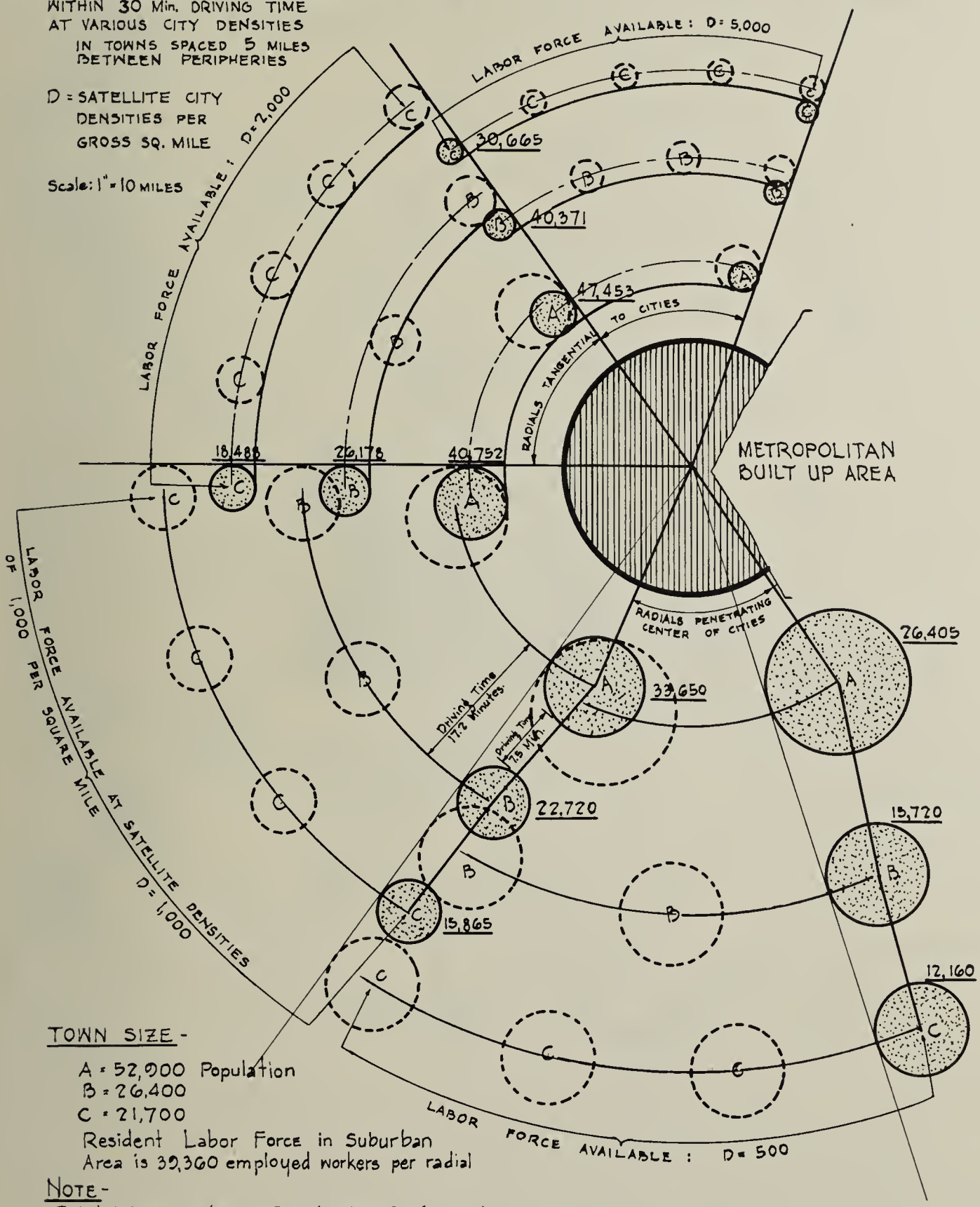
Schematic Diagram of

TOTAL EMPLOYED WORKERS AVAILABLE

WITHIN 30 Min. DRIVING TIME
AT VARIOUS CITY DENSITIES
IN TOWNS SPACED 5 MILES
BETWEEN PERIPHERIES

D = SATELLITE CITY DENSITIES PER GROSS SQ. MILE

Scale: 1" = 10 MILES



TOWN SIZE -

A = 52,900 Population
B = 26,400
C = 21,700

Resident Labor Force in Suburban Area is 32,300 employed workers per radial

NOTE -

Driving Time Between Peripheries @ 40 m.p.h.
" " Within Cities @ 20 m.p.h.
Industry assumed to be at Center of Town

CHART 11

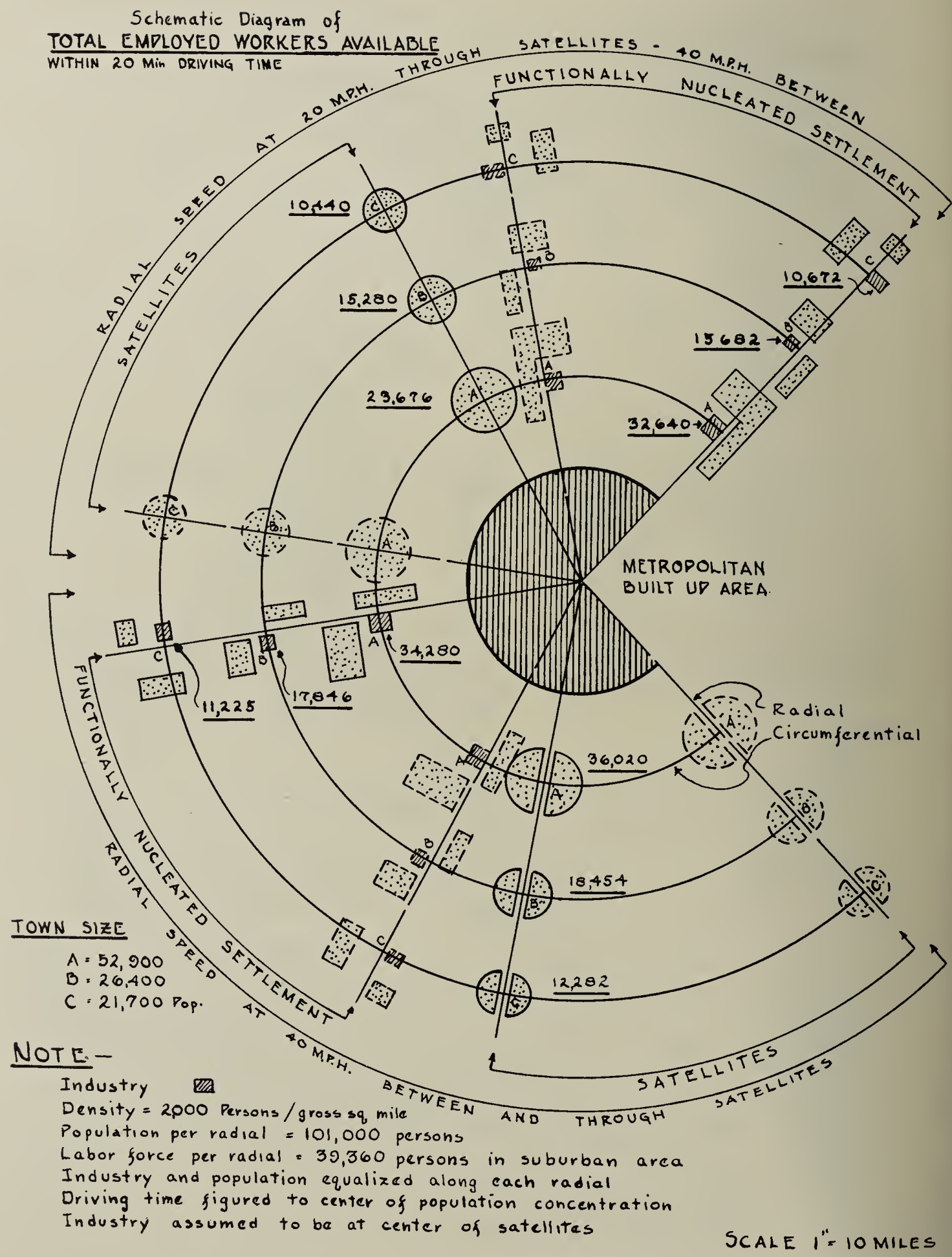
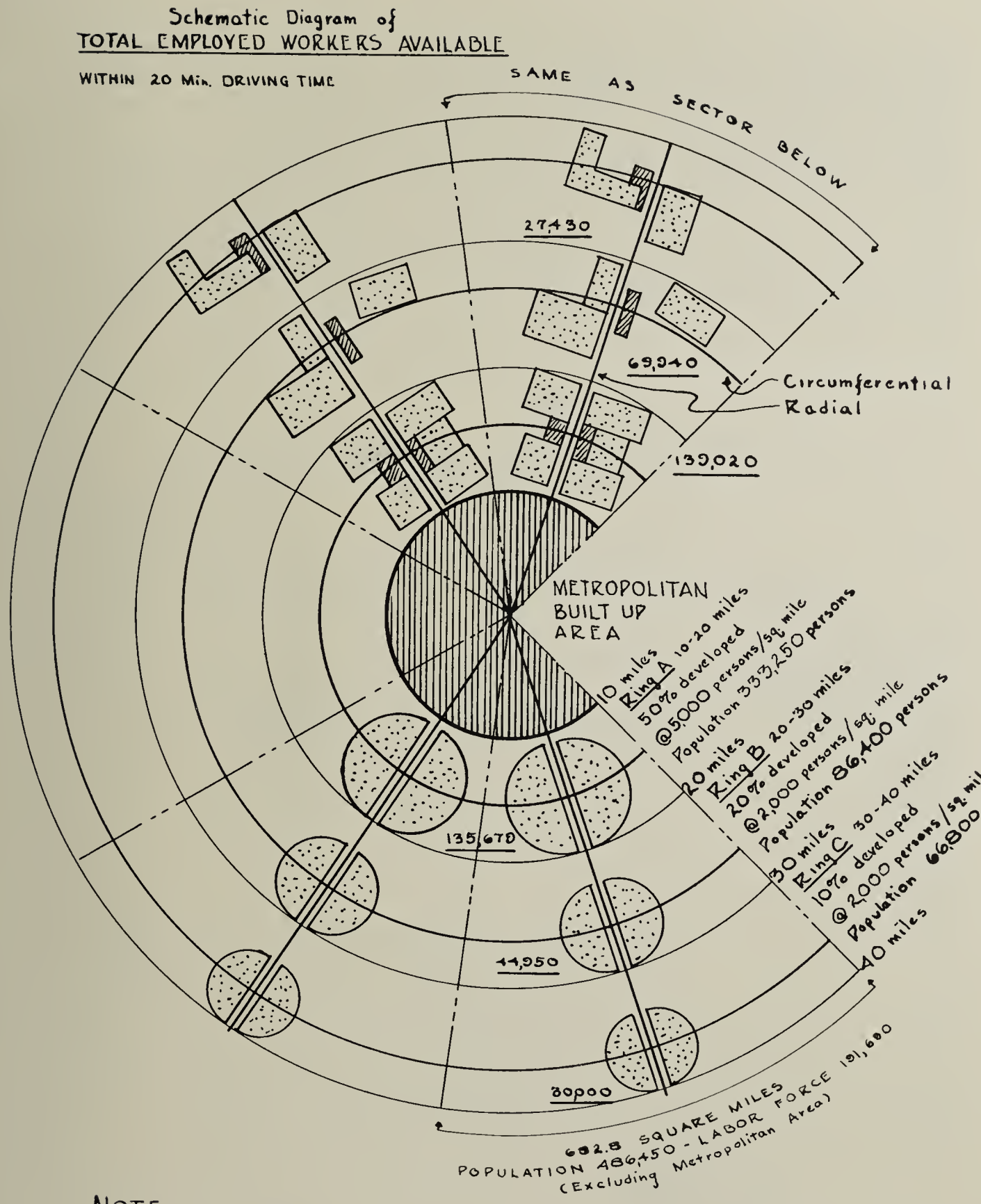

Schematic Diagram of
TOTAL EMPLOYED WORKERS AVAILABLE
WITHIN 20 Min DRIVING TIME
RADIAL SPEED AT 20 M.P.H. THROUGH SATELLITES
FUNCTIONALLY NUCLEATED SETTLEMENT SATELLITES - 40 M.P.H. BETWEEN
10,440
15,280
23,676
32,640
10,672
15,682
34,280
17,846
11,225
36,020
18,454
12,282
METROPOLITAN BUILT UP AREA
Radial
Circumferential
FUNCTIONALLY NUCLEATED SETTLEMENT RADIAL SPEED AT 40 M.P.H. BETWEEN AND THROUGH SATELLITES
TOWN SIZE
A = 52,900
B = 26,400
C = 21,700 Pop.
NOTE —
Industry
Density = 2000 Persons / gross sq. mile
Population per radial = 101,000 persons
Labor force per radial = 39,360 persons in suburban area
Industry and population equalized along each radial
Driving time figured to center of population concentration
Industry assumed to be at center of satellites
SCALE 1" = 10 MILES

CHART 12



NOTE—

SCALE 1" = 10 MILES

Industry ▨

Industry and population equalized along each radial

Driving time figured to center of population concentration

Industry assumed to be at center of satellites

The only criterion not previously discussed is that of functional interdependence. It is clear that wider spacing of higher density towns with balanced economies would tend to reduce interdependence of the several parts of the urban area. Space alone would be a relatively unimportant matter, however, as compared with administrative policies of government and business. Each satellite should, to the extent possible, contain its own sources of labor, food, fuel, electric power, and the like. Certain services can be centralized for the metropolitan area outside of the center, railroad junctions, communications centers, and wholesale marketing. These policies are, however, outside the scope of this report.

Table 15

Summary Scores of the Acceptability of Various Densities and Spacings of Satellites for Metropolitan Areas[a]

Criteria	Density					Spacing in Miles			
	500	1,000	2,000	5,000	10,000	3	5	10	More
Labor Supplies	0	1	2	3	4	4	3	2	0
Transportation Time	0	1	2	3	4	4	3	1[b]	0[b]
Municipal Services	0	2	4	4	2	2	2	2	0
Specialized Services	0	0	1	3	4	4	3	2	0
Housing Type	0	0	3	3	0[b]	1	1	1	0
Housing Location	0	1	2	3	2	3	2	1	0
Housing Cost	0	0	1	3	4	2	2	1	0
Amenity	0	2	3	4	2	1	1	1	0
Target Worthy	4	4	4	3	1	1	3	4	0
Target Separation									
Target Density	4	3	3	2	1	1	2	3	0
Functional Interdependence	1	1	2	3	2	1	2	3	0
Economic Efficiency	1	1	2	3	2	3	2	1	0
Total Scores	10	16	29	37	28[b]	27	26	22	0[b]

[a] Basis of scoring: 0 = Reject
1 = Indifferent
2 = Acceptable
3 = Preferred
4 = Best

[b] Reject Rating.

CONCLUSIONS

(1) The optimum pattern for metropolitan decentralization is one consisting of a core city performing principally specialized functions and surrounded by satellite or functionally nucleated developments which perform most manufacturing functions and provide noncentral specialized services for the metropolitan area.

(2) The density of satellites may range from 500 to 10,000 per square mile, depending upon required size, functions, and spacing. The optimum density of satellites, all factors considered, is from 2,000 to 7,000 persons to the square mile; a density of 5,000 persons to the square mile appears to have maximum advantages. These densities are buildable, conform to American housing preferences, and will provide adequate supplies of labor to meet most needs.

(3) The spacing of satellites should be from 3 to not more than 10 miles between peripheries, or roughly from 8 to 15 miles between centers, depending upon density.

(a) Where concentrations of more than 20,000 basic workers are required, densities must exceed 2,000 persons to the square mile, and spacing cannot exceed 10 miles to provide reasonable labor supplies at reasonable travel time.

(b) Where spacings of more than 10 miles are required, densities of 5,000 or more persons to the square mile are required under normal circumstances.

(c) Optimum spacings will be 5 to 10 miles where satellite densities are 2,000 to 5,000 persons.

(4) Satellite cities will draw heavily upon rural farm and nonfarm populations in the areas surrounding them for labor where high urban employment requirements exist. Densities in these areas of 200 persons to the square mile are adequate to meet all needs.

ADDENDUM

Method Used in Computing Charts on Employed Workers Available

Procedure for Charts 4-9:

Step 1: The total resident labor force and 40 per cent of that labor force were determined for each satellite as well as the central city. For the latter, 100,000 persons were assumed to be the maximum population drawn upon.

Satellite	Population	No. of Employed Workers	40% of Employed Workers
A	52,900	20,820	8,808
B	26,400	10,430	4,172
C	21,700	8,110	3,244
Part of Central City		39,400	15,760

Step 2: The total driving time was determined within the cities at 20 miles per hour, between cities at 40 miles per hour for the varying satellite densities, and for 3.2, 5.0 and 10.0 miles between satellite city peripheries. In addition, driving times along an assumed circumferential connecting the centers of satellites along additional radials were determined.

Step 3: Typical Computation. For city A the driving time within city A plus driving time to city B's periphery was determined. The difference between this sum and the assumed total driving time (i.e., 20 or 30 minutes) was the time left to be used within the satellite at 20 m.p.h. The percentage at this time to the total driving time across satellite B was obtained. This percentage was applied to 40 per cent of the labor force in satellite B to obtain the number of workers likely to be drawn from B to satellite A. The totals for A and B were then added to those of any other satellites (or to some proportion of the central city) to obtain the total number of employed workers available in satellite A and within the stated driving time.

Example: Satellite A; 3.2 miles apart; D = 1,000; 30-minute driving time.

12.3 minutes from center of satellite A to periphery
5.0 " between satellite A and B; and between A and metropolitan center

17.3 minutes—total

30.0 minutes—total driving time
17.3

12.7 minutes total driving time in B or metropolitan center
12.7 minutes = 73% of total driving time in B (which is 17.4 minutes);
12.7 minutes = 65% of driving time in metropolitan center to draw upon a full 100,000 people.

Hence:

20,820 = total number employed workers in A
10,250 = 65% of 15,760 employed workers in Meropolitan Areas
3,040 = 73% of 4,172 employed workers in B
2,220 = 26% of 8,328 employed workers in A^2 along adjacent radial East of A
2,220 = 26% of 8,328 employed workers in A^1 along other adjacent radial West of A

38,550 total employed workers available in A, at D = 1,000 and with 30-minute driving time.

Procedure for Charts 10-12

In addition to the above type of computation, percentages at 40 per cent of the number of employed workers in inter-radial satellites were computed where they were within a 30-minute total driving time in Chart 10. Such satellites lying within this driving time were assumed to be on both sides of the radial. It should be noted from the chart, that in towns of 1,000 or 500 persons per square mile, radials or circumferentials must pierce the centers of the labor pool to reduce driving times to a point where adjacent satellites or the metropolitan area can be tapped for labor supplies. At the higher densities tangential radials and circumferentials become feasible and advantageous since driving times within the higher density satellites are reduced to a fraction of the times required to traverse the lower density satellites.

Charts 11 and 12 test alternative patterns at D = 2,000 and D.T. = 20 minutes. In each chart the radials are assumed to penetrate the satellite in one pair of cases. Again 40 per cent of the employed workers in settlements second removed from any industrial area were assumed potentially available, and driving times were used to ascertain percentages of resident workers within the assumed market.

SECTION II
FORCES MAKING FOR CONCENTRATION IN THE CORES OF METROPOLITAN AREAS

INTRODUCTION

We have undertaken "To prepare a report on the forces making for increased concentrations in the core of metropolitan areas and the factors, if any, which might be utilized to abate further concentration . . . and encourage less vulnerable forms of development . . ."

The *metropolitan core* is taken to mean the more or less solidly built-up part of the central city of a metropolitan area plus, in some areas, similar contiguous districts outside the boundaries of the central city. Thus, for instance, all or nearly all of Cambridge would be considered part of the core of metropolitan Boston; some districts within the boundaries of Chicago might be considered outside the core, but Oak Park and Cicero would be included in it. Unfortunately, the data pertinent to this inquiry are not only very scanty, but are also often only available for civil divisions or areas. This means, in fact, that the metropolitan core becomes for the practical purposes of a quick analysis the central city of the metropolitan area.

In some parts of this study, particularly those dealing with retail shopping and office building space, we have been concerned primarily with a much smaller area, the *inner core*. It is roughly coterminous with the central business district of the central city plus its immediate environs. For these areas, only spot data are available.

Sections IIA through D, inclusive, discuss four major kinds of land use in metropolitan cores. Within the stringent limits of available facts and time, an attempt is made to assess the forces of concentration working on each. Concluding sections outline the factors and measures that might be used in behalf of less concentrated development in the future. The four kinds of land use are: (1) manufacturing industry; (2) housing—measured here by population figures; (3) retail trade; (4) office buildings.

A. MANUFACTURING INDUSTRY

The distribution of production workers in manufacturing industries among various types of localities has shown remarkable stability over the past half-century. This fact is quite clear from Table 16.* When one considers the enormous growth in manufacturing and population over the period covered by this table, the spectacular rise of many industries as well as the sharp decline of others, and the many almost revolutionary changes in techniques, transportation and materials, the changes in the broad pattern of industrial location seem small indeed. Although this suggests difficulties for any policy of encouraging or inducing industrial dispersal, in our opinion the difficulties are not insuperable. In any event, however, this basic fact should not be ignored nor belittled.

For our purposes, the chief facts from Table 16* for the period 1899 through 1939 are: (1) The proportion of production workers in the major industrial areas (column F) declined slightly—from 57.8 to 54.9 per cent. (2) The proportion in the areas of secondary concentration (J) increased slightly—from 15.4 to 17.8 per cent. (3) The proportion in the rest of the country (K) was almost the same at the end of the period (27.2 per cent) as at the beginning (26.8 per cent). (4) Within the major industrial areas, the principal or central cities (A) lost ground slowly but quite steadily—39.5 per cent in 1899 to 32.0 per cent in 1939—while the outlying sections (C) gained from 14.6 to 20.0 per cent.

In short, the first three (particularly the first two) of these four facts indicate a weak and uneven tendency toward industrial decentralization, which was of significant size only in the South Atlantic states. The fourth fact shows a somewhat stronger and steadier movement toward industrial dispersion. It was most noticeable in the Middle Atlantic, East North Central, and Pacific states.

From 1939 to 1947, the picture is unclear. Contrary to a common opinion, despite a more than 50 per cent increase in the number of production workers, the percentage distribution changed very little. Tables 17* and 18* make possible some more detailed comparisons but hardly change the general conclusion. (These tables use as the areas of primary concentration the 1947 Census of Manufactures' 53 standard metropolitan areas with 40,000 or more production workers instead of the 33 industrial areas first recognized by the Census in 1929.) The 1947 figures were greatly influenced by the conditions brought about by World War II. Several factors worked to stabilize the distribution of workers during this period: more intensive use of existing plants; extension of plant facilities whenever possible rather than building branch plants in

*See pp. 72b - 78b

order to save on utility lines, streets, transport facilities, etc.; the widespread employment of secondary wage earners—women, young people, and retired workers who resided in large numbers in the existing industrial centers.

It seems justified, therefore, to say that no one should conclude that 1939 marked the end of the slow trend toward industrial dispersion even of the uncertain tendency toward decentralization. In fact, one set of post-war data suggest that after World War II the trend toward dispersion was renewed with added strength and was accompanied by a substantial decentralization outside of the areas of secondary concentration—i.e. in the "rest of the country." These data, the Engineering News Record's reports on industrial construction contracts, are presented in Table 19 for the period 1945-1949 by the same locality breakdown as in Tables 17 and 18. Although we have not seen the later figures, we understand that another tabulation of the same data for an 18-month period in 1950 and '51, made by the National Security Resources Board, supports, in general, our Table 19.

These data, of course, cannot be compared directly with those for production workers. Also, serious question may be raised as to whether they are a fair sample of industrial construction for the country as a whole. At least, however, they do show that since World War II a substantial volume of industrial building has been taking place outside of the cores of metropolitan areas. Although it does not seem worthwhile to try to summarize them here, several studies of the metropolitan regions of New York, Chicago, and Detroit during the period from the middle 1920's to 1950 support in various degrees the conclusion that plant construction has been dispersing throughout in these gigantic industrial areas.

With this much background, we turn now to the factors or forces that have been making for industrial concentration in the cores of metropolitan areas. We believe the major forces to this end are:

(1) The large markets for consumers' goods that are provided by the populations of the chief metropolitan areas.

(2) The linkages among many industries. These are mainly of three kinds: (a) The products of one plant are the raw materials of another; (b) The by-products of one industry are used in the processes of another; (c) The labor supply of one industry —employing largely male workers—makes available and may help to support other workers—usually female—of another industry.

(3) Relatively rapid and economical transport facilities for both raw materials and manufactured products—for example, switching yards and docking facilities that bring materials and take away products from plants with only one process of unloading or loading.

(4) A large and varied labor supply or labor pool—including both wage and salary workers.

(5) Other "economies of urban concentration." Besides transfer services and labor supply, these include superior banking and other credit facilities; usually lower interest, insurance, and utility rates; direct access to superior distribution channels—jobbers, wholesalers and the like; greater specialization of firms and plants by functions, which makes possible relatively easy sub-contracting for parts or operations and even for repair and maintenance of plant and equipment; and smaller inventories of materials and other components. These latter factors are particularly important to new and small firms with relatively little working capital and without strongly established positions in the markets for their products.

(6) Personal reasons which include (a) the preferences of top management officials (and their wives) for metropolitan living and (b) again for new firms set up by former management officers of larger corporations, their owners' and managers' established connections and reputations with banks, jobbers, suppliers, and key operating personnel.

(7) Cheap space in older buildings. This is of major importance to new and struggling firms, particularly in times of high building costs. Such space, although far from ideal in many respects, saves time in getting started, capital outlays, and even on operating expense. Under conditions such as existed immediately after World War II, availability of buildings became a major consideration in locating many plants of companies that could not be classed as new or struggling.[1]

(8) Inertia—physical, economic, and psychological. Plant buildings have long physical lives. Established business connections are not casually broken. If these be tolerably satisfactory,

[1] See, for example, Ellis, George H., WHY NEW MANUFACTURING ESTABLISHMENTS LOCATED IN NEW ENGLAND: AUGUST 1945 TO JUNE 1948, Monthly Review, Federal Reserve Bank of Boston, April 1949.

owners and managers, particularly of medium-sized and smaller plants, ". . . rather bear those ills we (they) have than fly to others we (they) know not of." Also, a major plant move or branch is a very substantial and serious operation for which only a very few of the largest corporations have special personnel, facilities or arrangements. Apparently in the overwhelming majority of companies, including most of the largest and most successful, the planning for moves or branch plants is done by *ad hoc* committees or teams of officers with only incidental outside help.[2] Decisions on these matters can easily be put off from one year to another. When business is poor or its prospects dark, it is not the time to incur the disruption, outlays, and expenses of such a move. When things are better, many other matters may have higher time priorities. Finally, some rather intangible but not inconsequential attitudes and feelings—for example, pride, status, prestige, etc.—grow up as the result of years of operation in a locality and these tend to inhibit moves and to keep at least minor extensions or expansions in the same area.

The effectiveness of all of these factors varies from industry to industry and often from one firm to another. We know little about many of these variations.

This analysis, although admittedly rather generalized, cannot be fully appreciated by a point-by-point examination of the forces or factors listed. These forces do not operate singly and independently but in various combinations and *cumulatively* over time. Thus, for example, a sizeable plant may move into or grow up in, say, Cleveland primarily because it has important linkages with steel mills there. Its payroll adds to the attractiveness of this locality to other, market-oriented, consumer goods industries. These, in turn, help attract and support a larger and more varied labor pool. These industries plus many others encourage the development of specialized services that make it easier for new plants to make their starts in this city.

All of the eight forces or factors listed above, with possibly one or two exceptions, are probably effective in respect to the outlying parts are well as to the cores of metropolitan areas. It seems reasonable to say, however, that most of them operate more strongly in the core areas.

[2] McLaughlin, Glenn E. and Robock, Stefan, WHY INDUSTRY MOVES SOUTH (National Planning Ass'n. Washington, 1949), Appendix C.

Core areas have some serious disadvantages for industrial location. These, too, vary from industry to industry. Unfortunately, it seems that these drawbacks are not as susceptible of clear statement or measurement as many of the forces or factors that make for concentration. For example, a manufacturer, or at least the head of his shipping department, would know to a few dollars how much he saves in freight charges by being in a certain metropolitan location. He probably won't know and no one can give him a reasonably reliable estimate on how much road congestion costs him in trucking charges or how much second-rate living conditions increase his labor turnover.

Finally, the few recent studies of industrial location strongly suggest that, speaking very broadly, the forces that make for location in metropolitan cores work more effectively on medium-sized and smaller companies than they do on large corporations establishing branch plants. Conversely, the attractions of outlying localities in metropolitan areas and of independent, medium-sized towns seem greater to those making decisions on plant locations for large and diversified corporations.[3]

B. HOUSING — POPULATION

For many years before 1940 a fairly widespread pattern of population change in metropolitan areas had been evolving. It is so well-known that it needs very little explanation. In very broad terms, it showed a series of districts or areas, more or less concentric to the main business district of the central city. The innermost of these districts usually declined fairly substantially in resident population, the rate being higher in times of relatively good business and employment conditions and slower when times were bad. Moving outward from this district, the rate of decline fell off; soon an area of substantially stable population was reached and beyond it districts of growth or increase. In the larger metropolitan areas, these last districts might extend into bordering suburbs, and usually even more rapid increases would occur in many of the suburbs extending outward in radials from the central city.[4]

[3] See Ellis, *op. cit.;* McLaughlin and Robock, *op. cit.;* Dickson, Paul W., DECENTRALIZATION IN INDUSTRY (National Industrial Conference Board, New York, 1948); and INDUSTRIAL MOBILITY IN MICHIGAN (Institute for Social Research, University of Michigan, 1950).

[4] This pattern of change, with of course very substantial variations, has been shown in many local studies. Probably the most satisfactory analysis of more than one locality is that of Warren S. Thompson, THE GROWTH OF METROPOLITAN DISTRICTS IN THE UNITED STATES: 1900-1940 (Government Printing Office, Washington, 1948) Chapter 2.

The preliminary reports from the census of 1950 seem to indicate that this pattern of population change has continued. More than four-fifths of the total population increase of the United States from 1940 to 1950 took place within the 168 standard metropolitan areas (SMA). Of the total increase in the population of SMA's, 67 per cent went into the 32 areas with 500,000 population or more in 1950. While the population of the country increased 14.3 per cent during the decade, that of the SMA's went up by 21.2 per cent and all the rest of the country by only 5.7 per cent. Within the SMA's, the central cities increased by 13.0 per cent; outlying parts of the areas by 34.7 per cent. In absolute numbers the central cities gained 5.6 millions persons and the outlying parts 9.0 million.[5]

Certainly these broad facts seem to confirm the trend. But Map 1 at the end of Section II, which was prepared by the Chicago Community Inventory of the University of Chicago from 1950 census figures for census tracts, shows that, for the city of Chicago at least, this pattern of metropolitan population change was substantially modified during the decade of the 1940's. Although the altered pattern is irregular, much of the inner ring did not decrease but rather increased in population—in some parts very rapidly. The districts of moderate decrease (up to 10 per cent) covered a large proportion of the city area. They extended to the western boundary of the city in some places and far out toward the northern and southern boundaries. Most of the tracts of more rapid decline were spotted throughout this very large area.

No generalizations can be drawn from the data from one city. Chicago, however, partly because of its level terrain, showed the traditional pattern of change quite clearly in the years before 1940. The broad data for its metropolitan area still conform to the general pattern: the 1940-1950 increase in population in the city of Chicago was 6.6 per cent; in the outlying parts it was 31.2 per cent. Quite possibly, therefore, the modified or new pattern of change within its central city may also be found in at least some other metropolitan areas.

What are the forces of concentration that may be identified with some confidence? Four types of influence seem quite clear:

[5] These figures were taken or calculated from Bureau of the Census, 1950 CENSUS OF POPULATION—PRELIMINARY COUNTS, Series PC-3, No. 3, Nov. 5, 1950, and Series PC-7, No. 4, Nov. 20, 1951.

(1) The metropolitan cores, particularly their inner districts, are by all odds the largest single supply of cheap housing. Much of it is poor, but it is relatively inexpensive. Many low-income families, particularly recent migrants to these areas, are attracted by or even compelled to seek living quarters in this centrally located pool of largely obsolete and blighted housing.

(2) Incoming families of the so-called minority groups, mostly Negroes and Mexicans, not only are largely low income but because of the various forms of discrimination against them, naturally go to those areas where members of their groups predominate or, at least, have a good foothold. In such districts they will be admitted to housing of some kind. Also, they will find both facilities and customs they can more readily understand and use with minimum risk of embarrassment.

(3) The ubiquitous pattern of transit lines converging on the central business district makes near-in residential areas relatively more accessible to a *variety* of sizeable places of employment than any other sector in metropolitan areas. This factor is most influential with families of more than one wage earner and with those whose chief earner, for one reason or another, often changes his place of employment.

(4) Inertia, institutional ties, group and district loyalties, status and recognition in such groups or areas play a substantial part.

Although it is often said that many people simply like big city ways of life with their color, excitement, and crowding, and that central metropolitan concentration simply reflects this fact, what little evidence is at hand on this point indicates the opposite. Thus, Elmo Roper's Fortune Survey for April 1946 concluded that "Except for farmers . . . the U. S. people show a pronounced yearning for life in the suburbs". In December 1948, the same Survey of a nationwide sample of persons in the 18-25 and 40-55 age groups included the question: "If you had your choice, where would you like best to live?" The replies were: suburb—22 per cent; country—21 per cent; small city—20 per cent; small town—19 per cent; big city—17 per cent; no opinion—1 per cent.

Here again our information is woefully insufficient, but it does seem worth emphasizing that quite probably the broad, underlying preferences and values of a large proportion of the American people run not in the direction of metropolitan core concentration but against it.

C. RETAIL SHOPPING

As might be expected from the patterns of change in the distribution of population in metropolitan areas, metropolitan cores and central business districts within them have been losing ground relatively in retail shopping at least as far back as the inclusive data of the Federal Census of Business are available—1929. Thus, from 1929 to 1948 the number of stores in the 32 cities with population of 250,000 and more in 1929 decreased by 1 per cent and the dollar volume of sales increased by 119 per cent. From 1939 to 1948 (half of the former period) the number of stores in outlying parts of these 32 metropolitan areas increased by nearly 13,000 and the dollar volume of sales went up by 225 per cent.[6] A more detailed comparison for the Chicago metropolitan area shows that in 1935 the Loop stores did 26 per cent of the city's retail business and in 1948 about 18 per cent. For this metropolitan area, the city of Chicago had 78.7 per cent of the dollar volume of retail sales in 1935 and 72.6 per cent in 1948; Cook County outside of Chicago had 9.7 per cent in 1935 and 12.3 per cent in 1948; other parts of the metropolitan area—11.6 per cent in 1935 and 15.1 per cent in 1948.[7]

Since World War II some scattered evidence indicates that this trend has accelerated. The 1948 census figures probably reflect relatively little of this later movement. The evidence for acceleration consists largely in the development of large regional shopping centers in outlying parts of many metropolitan areas and occasional partial tabulations of branches set up by central business district department and specialty stores. In 1951, for example, the Regional Plan Association, Inc. found that in the preceding 25 years at least 80 suburban branch stores had been established in the New York area and, of these, more than half had been opened since the end of War II. Further, one-third of the central stores with suburban branches had located in all three major sectors of the region—Westchester—Fairfield, Long Island, and Northern New Jersey.[8]

[6] These comparisons, rather unsatisfactory for our purposes, are found in MONEY-MATTERS—A BULLETIN OF ECONOMIC INTERPRETATION, (Institute of Life Insurance, New York) August, 1950.

[7] Press Release, University of Chicago, Feb. 1, 1952, based on Albert J. Reiss, Jr., and Leonard Z. Breen (ed's.) GEOGRAPHIC DISTRIBUTION OF RETAIL TRADE IN THE CHICAGO METROPOLITAN AREA, 1948 (Chicago Community Inventory, University of Chicago, 1952).

[8] SUBURBAN BRANCH STORES IN THE NEW YORK METROPOLITAN REGION, Regional Plan Bulletin Number 78, December 1951. (Regional Plan Ass'n. Inc.—New York).

The forces making for concentration of retail shopping in the inner cores of metropolitan areas, which seem to be losing some of their effectiveness, are well-known:

(1) Many central business stores, particularly department stores and specialty shops handling fashion goods, offer greater choice to customers. In the larger cities groupings of such establishments in one or two sectors of the central business district heighten this attraction.

(2) Heavy advertising in metropolitan papers pull many customers and helps to build up prestige for the stores and the district.

(3) Out-of-town (out-of-metropolitan area) customers who come into the central city by train or bus usually find the downtown stores readily accessible.

(4) Many mass transit lines and urban highways converge on the inner core.

(5) Big-city department stores are, in effect, amusement centers as well as places to buy things.

The factors in the dispersion of retail shopping are also quite apparent:

(1) The increasing use of automobiles by shoppers has increased the accessibility of outlying centers and has produced congestion and parking troubles in the inner cores.

(2) Merchants in outlying parts of metropolitan areas are more and more trying to exploit their advantages in convenience, particularly for women shoppers in times when domestic servants are much rarer than they used to be and when even daytime baby sitters are often hard to come by.

(3) The dispersion of relatively high-purchasing-power population has brought within easy driving distance of many outlying centers enough purchasing power to support stores that can offer a considerable variey of goods and services—sufficient, probably, to reduce substantially the need for frequent trips to the large establishments in the inner core.

(4) In the larger metropolitan areas, the suburban sprawl has

gone so far that trips to the inner core are inconveniently long and tiring—quite aside from congestion and parking troubles when it is reached.

(5) Of somewhat lesser significance are the growth of name-brand products of many kinds and the fact that much of the advertising of downtown department and specialty stores can easily be made to benefit suburban branches—"Also available at our——and——suburban stores."

Will this dispersion of retail shopping facilities continue? Although relatively little is known about its post-World War II phase, the consensus among both urban planners and marketing specialists seems to be that it will. Some of the latter, however, are voicing warnings. They fear overexpansion from the present race to set up branch stores. They point out that some of the recently developed regional centers are running into unforeseen troubles. They emphasize that no one can be sure yet whether the big regional centers will draw most of their trade away from the inner core or from smaller and less attractive shopping districts in outlying areas.

In January 1951, the magazine *Business Week* ran a story, *Retail Experts Looking at the Future*. The story was based on interviews with six nationally known specialists in marketing—two in universities and four in business. Under the heading of "Geographical Shifts," the following two paragraphs would be subscribed to by many students of retailing:

> The marketing experts see a speedup of a trend that has been going strong for quite a while—the movement to the suburbs. It may be slowed by the shortage of materials, high construction costs, and a scarcity of retail properties. But it will go on.
>
> Silbert (Vice-President of Federated Department Stores) thinks that from now on the stress will be on the far-off suburbs rather than the ones closer to town. But he doesn't base his reasoning on fear of the atom bomb. He thinks land near-in is too expensive for mass development. McNair (Harvard) thinks that this continued decentralization of cities will require the government to permit the construction of new distribution facilities to keep up with the out-of-town growth.[9]

[9] RETAIL EXPERTS LOOKING AT THE FUTURE, Business Week, January 6, 1951, p. 65.

D. OFFICE SPACE

Usually it has been assumed that nearly all of the buildings providing office space in urban areas, except for doctors', dentists', and other professional people's offices in outlying business districts, are found in or near the central business district or inner core of large cities. Casual observation seems to confirm this. This view also appears to be shared by the National Association of Building Owners and Managers, since it collects data only for the larger cities of the country, and for Chicago, numbers office buildings by streets in the inner core known as the Loop.

Evidence of the dispersion of office buildings to peripheral sections of metropolitan areas or of decentralization to smaller communities outside of metropolitan districts is skimpy and appears only sporadically. Announcements of firms planning to locate new office buildings in outlying districts have been sufficiently rare to make "news". All in all, no definite trend can be inferred from information available on the extent of dispersion of office space that has taken place to date. If anything, the surveys of the National Association of Building Owners and Managers would seem to indicate that the central business districts are maintaining, if not strengthening, their hold on volume of office space. It is reported that in the period between the end of World War II and the start of the Korean conflict—roughly five years—some 30 million square feet of new rentable office space were put on the market. Since, according to the Association index, 220 million square feet of space were available at the beginning of that period, the increase over these years was about 13.6 per cent. Moreover, the ratio of occupied to total available space reported during the postwar years has been consistently above 95 per cent. [10] This suggests a strong demand for office space in the central cities and presumably in the central business districts of these places.

Only fragmentary information is presently available on which industries or operations are choosing office sites outside of the inner cores of principal cities. Insurance companies have participated in the limited outward movement that has occurred thus far. There are indications that such companies do not abandon the central district entirely but remove their more or less routine operations—for example, the processing of policies and premiums—to outlying sites. In another

[10] Information supplied by Mr. William McLaughlin of the National Association of Building Owners and Managers, letter dated May 9, 1952; also, Dale R. Cowen, OCCUPANCY REGISTERS THIRD CONSECUTIVE GAIN, Skyscraper Management, 36 (November, 1951), 3-6.

field, the publishers of a weekly magazine *(Time)* plan to move to a site about one hour's commuting time from their present headquarters in Manhattan. Another magazine, published monthly *(Reader's Digest)*, has maintained all of its offices in a small town for a number of years. But no daily metropolitan newspapers are so located, evidently because they must be in close contact with the place where news is made, and more important, because of their need for a focal point for speedy distribution of their product. In still a different line, a major grain brokerage house in Minneapolis shifted 125 employees out of a total of 575 to a location 13 miles from the heart of the central city. But three-fourths of its work force continued to be situated in the central district office near the trading floor, banks, and railroad terminals. Other individual cases of geographical decentralization of office operations are those of an oil company and a utility company, both in the New York area.

Why have office buildings been clustered in the inner core? The reason for this concentration can be explained partly in historical terms. Those lines of activity that require office space—manufacturing corporations, sales concerns, banks, insurance companies, security brokers, advertising firms, lawyers, accountants, doctors, and other professional people—must be in close contact with both the local population and in some cases a regional population and many of them with each other. Before the day of the automobile and telephone, the focal point of the inter- and intracity transportation systems was accessible to the largest number of people. It was here that customers, employees, and officers, interdependent firms and operations, could most easily come together. Office buildings tended to be located in the "downtown" section of American cities intermingled with or in districts adjacent to other high-intensity users of central locations, such as retail stores, fashion goods shops, and hotels. The initial grouping of these activities enhanced the attractiveness of the area to firms or services in similar or allied lines and strengthened the concentration.

The advent of the automotive transport system and of a telephone communications network has widened the geographical boundaries within which certain types of activity can conveniently locate. Presumably those industries or operations that do not depend upon direct personal contact with a large volume of people and are not closely linked with a number of other industries or processes can be advantageously located in peripheral parts of the metropolitan district. But even for these activities a degree of "recentralization" would appear to offer economies.

A tentative hypothesis on the selection of office sites is that most nonmanufacturing industries and firms would prefer a central location for at least many of their office operations. If direct contact with the maximum number of people is necessary, a location in the inner core may be essential. Highly specialized firms or activities that depend on close contact with allied businesses or professions—investment bankers, security brokers, legal and medical specialists—must also be situated in the central district.

For other firms or activities not so completely dependent upon a central location for their economic existence, other considerations favor a site in the inner core. One of these is the so-called external economies that are found there in the form of mass transit facilities, restaurants, hotels, a retail shopping district, etc. To provide such facilities on an individual basis would be extremely expensive, prohibitively so for most small and medium-sized firms. Many of them could be supplied outside the inner core but are not available in adequate quantity or quality.

Another factor, still insufficiently explored, is the journey-to-work pattern of office workers. Many of these workers depend upon mass transit facilities for cheap and convenient transportation from home to work and back. Higher salaries or wage rates might be necessary to induce such employees to travel longer distances (and times) or by means of private automobiles. But it is entirely possible that office operations located in suburban or satellite communities could readily attract workers from the neighboring residential population, that is, draw in people who would otherwise have to commute to the central district. This raises other questions that cannot as yet be answered in quantitative terms. How important to office workers is the opportunity to shop and do errands close to their place of employment? Do such people prefer to work near the bustle and excitement of the central business district? Published material on these subjects has been mainly in the nature of assertions rather than conclusions based on facts and analysis.

Some of the reasons given by businessmen who have dispersed their office operations are:

(1) The inner core lacks physical space to expand.

(2) Rents and real-estate prices in central locations are prohibitively high.

(3) Commutation to the central district is increasingly difficult and expensive so that this area is losing one of its principal advantages over outlying sites.

(4) It is becoming harder to hire first-class help in some of the more unsightly, congested downtown areas. (This complaint is specific to parts of New York City, but may apply elsewhere.)

(5) The management of decentralizing firms thinks that workers will be happier and more efficient in less crowded or more natural and pleasant surroundings.

(6) Manufacturing firms find it more convenient to maintain offices at their plants.

(7) Similarly, the removal of certain merchandising functions to outlying areas has attracted related office operations.

Although these factors cannot be objectively weighed, it is probably true that so far the "squeezing out" forces have been more powerful than the positive attracting forces. It appears that the bulk of activities that require office space (in terms of floor space rather than the simple number of firms) would prefer a location in a centralized district. However, some of the advantages of the inner core—relatively inexpensive mass transit facilities, restaurants, etc.—could be obtained in outlying districts provided the new groupings were sufficiently concentrated.

E. SUMMARY

We would emphasize the following four points from our analysis:

(1) Although the forces making for concentration in metropolitan cores are many and, in combination, powerful, they are probably less formidable today than they have been at any time since the beginning of fairly intensive industrialization of the economy some seventy or eighty years ago. Not only are they losing some of their strength, but the offsetting influences toward dispersion are relatively stronger and seem to be increasing in effectiveness.

(2) The four major land uses examined are, in order of their responsiveness to present forces or future measures in behalf of dispersion, (a) housing-population, (b) retail shopping, (c) manufacturing industry, and (d) office space.

(3) Under the conditions of shortage and very high construction costs since World War II, the existing supplies of old,

obsolete, largely blighted but relatively inexpensive residential and industrial buildings constitute a force for concentration much greater than is commonly recognized.

(4) In all four kinds of land use, but again particularly in respect to housing and manufactures, the intangible considerations of custom, tradition, established practice, and inertia are easily underestimated.

F. SOME BASES FOR POLICY

Before putting down our more specific recommendations for ". . . actions which might be taken to reduce the incentives for or limit the extent of further concentrations of business and population in core areas and to encourage or channel such growth . . . into peripheral or less vulnerable places," we would stress a few prerequisites of any policy reasonably directed to these ends. Our suggestions come not only from the analysis outlined in the preceding pages but also from review of the proposals for and starts toward a Federal Government policy. We are convinced that no half-hearted, timid, pedestrian approach has a ghost of chance of success.[11] On the other hand, a bold, vigorous, multi-pronged attack might produce worthwhile results within the next five or ten years. We would stress, therefore, the five points below. In our opinion, they are the minimum preconditions of any policy worth undertaking:

(1) It should be recognized that the job is not an easy one; it bristles with obstacles and pitfalls. There are no one or two simple measures that by themselves offer any prospect of success. The measures adopted should add up to a broad and varied attack, and they will be expensive.

(2) Although in one sense this is an emergency matter, little or no groundwork of public understanding has been laid for an effective policy. It will at least seem to affect adversely the real or imagined interests of various groups—some of them well-organized and vocal. In very important respects, therefore, the program must be an educational undertaking. Many groups and organizations must be brought in early and given a chance to feel that the policy is partly their work and its success partly their responsibility. Among these groups

[11] This does not deny the probability that dispersion of some kinds of land use in metropolitan areas will continue—policy or no policy.

are local officials and organized labor, which sometimes has looked askance at industrial dispersion. Also, the problems and the policy must be dramatized—not primarily by the usual advertising and publicity techniques but by arranging for the announcement of policy to come from persons whose names command respect and by continually pointing out, by every possible means, what the proposals would mean to the welfare of the man and woman in the street and their families. It will be hard and often discouraging work but the aim should be at least a degree of public understanding, acceptance and support comparable to that accorded to British proposals for town planning and reconstruction immediately after World War II.

(3) The program will call for vigorous and intelligent administration by an agency that believes in it.

(4) The few specialists in urban development and metropolitan planning know very little about many sectors on this front. The information and knowledge now available should be supplemented as rapidly and as thoroughly as possible by more analysis and research, both short and long term. As examples of the kind of additional study needed, mention is made of two subjects that have been touched on: (a) the differences in effectiveness among industries and industry groups of the major forces making for concentration and for dispersion; and (b) the feasibility, under various conditions and forms of inducement, of functional dispersion in big users of downtown office space—for example, insurance companies, banks, manufacturing corporations. The results of this analysis and research must be fed into the processes of policy formulation and public education just as rapidly as possible.

G. MEASURES RECOMMENDED

The title of this section might better read—Measures Recommended for Further Consideration. The limited time available for this study makes possible little more than a tentative start toward sound Federal policy on an issue as complex and far-reaching as this. We are convinced, however, that the kind of analysis we have outlined above indicates several sub-objectives on the way toward a more dispersed and less vulnerable pattern of development for metropolitan areas:

(1) Substantial areas of good, buildable land must be made available in outlying parts of metropolitan areas. Industries

and commercial establishments (and secondarily, residential builders) should have a reasonable degree of choice of such sites. They will go ahead more rapidly in these areas only if they are freed in part from the present difficulties, delays, and frustrations that come from site selection, arranging for necessary public and utility services and facilities, negotiating with several land owners, overcoming local resistances, trying to make sure of housing for key personnel, etc.

(2) Ways and means must be found to offset the concentrating pulls, particularly for smaller and newer industrial plants, of the old, industrial space and the existing supply of lower income housing in the metropolitan cores.

(3) Transit and transport facilities, including the major highway network in metropolitan areas, must be planned and developed to give satellite locations a better relative position than they now have, by and large, in accessibility and convenience.

(4) More comprehensive and effective planning for metropolitan areas must be encouraged.

(5) In the interests of simple fairness as well as a means of mollifying opposition, the Federal Government should offer help to central city governments to the extent that their financial position is materially worsened by the program of urban dispersion in its various forms.

(6) Because the primary objective of such a program is to strengthen national defense and security, most of the specific aids and inducements in the program should come from the Federal Government. As far as possible, however, the specific financial aids of the program should be limited in time as well as in amount. The programs should be devised primarily to offset particular costs and hazards of fairly widespread and rapid development of outlying localities in metropolitan areas.

In light of our conclusions on these points, therefore, we offer several suggestions for further study and discussion.

(1) Any standards arrived at as to densities of development, location, and types of construction ought to be made conditions of existing and future Federal aid to public and private

urban development. These aids include FHA insurance, PHA loans and grants, loans from the regional banks of the Federal Home Loan Bank System, VA guarantees, Title I loans and grants for redevelopment projects, certificates of necessity for rapid amortization for tax purposes, guaranteed and direct loans to defense plants, contributions toward the costs of urban highways and airports, etc. Although this is an obvious proposal, it is much more easily said than done—as experience since August 10, 1951 shows.

(2) Local public responsibility, with Federal aid, for preparing land outside of metropolitan areas for development should be extended. In addition to broader state-enabling legislation, the existing Federal law (Title I of the Housing Act of 1949) should be revised to cut its tie with housing and to encourage open land undertakings. In addition, the Federal Government should offer to meet at least some of the carrying charges of local re-development agencies that go ahead in preparing sites for housing, industrial, or commercial development in advance of agreement with specific users.

(3) To this same end, Federal loans and grants should be made available to satellite municipalities for community facilities (schools, streets, water, sewers, etc.) necessary to encourage and support new industrial and residential development. Amendment of some state legislation on municipal debt limits may be necessary to make this measure fully effective.

(4) Low- and middle-income housing in outlying parts of metropolitan areas should be encouraged by Federal aids. The aid to housing in these locations should be more generous than to that in metropolitan cores. Unless vigorous action of this kind is obtained, dispersion of urban development will be seriously slowed by the fact emphasized above—the concentrating effects of the existing supply of low- and middle-income housing in metropolitan cores.

(5) To offset the similar condition in industrial plant space and to reduce the considerable risks and delays in providing suitable plants for small and new enterprises in satellite locations, the Federal Government should (a) recommend state-enabling legislation for local public agencies, either the present redevelopment agencies or others, to build industrial estates with space for rent, with or without purchase options, or for sale;

and (b) be prepared to make low-interest-rate loans, to purchase preferred stock, and possibly to share some percentage of any early losses in such enterprises undertaken by public or private agencies; the latter should be made under suitable safeguards.

(6) Even with the aids stated in paragraphs 2, 3, and 5, industrial space in satellite locations may still be at a cost disadvantage with that in older buildings in the metropolitan cores. Additional inducements to the smaller and newer firms may be necessary. This could take two forms: (a) rapid depreciation for tax purposes (over approximately 10 years) of investment in plants and facilities and (b) rent subsidies for a period of time of perhaps 5 years—which are limited to the difference between rentals of available space in satellite localities and in the metropolitan cores.

These two forms of aid need not necessarily be offered to the same classes of industrial enterprises. A case could be made for making (a) available to any industrial enterprise going into a satellite locality and restricting (b) to new and small undertakings.

(7) Because of the importance of both highway and mass transit facilities to the physical structure or pattern of metropolitan areas, their further development should be made to contribute to dispersion of population and industry. As to highways, Federal aid to the major kinds of urban arteries should be sharply graduated so that circumferential roads and desirable connections among satellite towns would receive substantially more Federal help than radials feeding more and more traffic into and out of core areas. Mass transit facilities or systems pose a more difficult problem but we believe that the forms of aid proposed in paragraph 5 (b) of this section could be adapted to public transit systems in respect to lines and facilities that would encourage patterns of dispersed development.

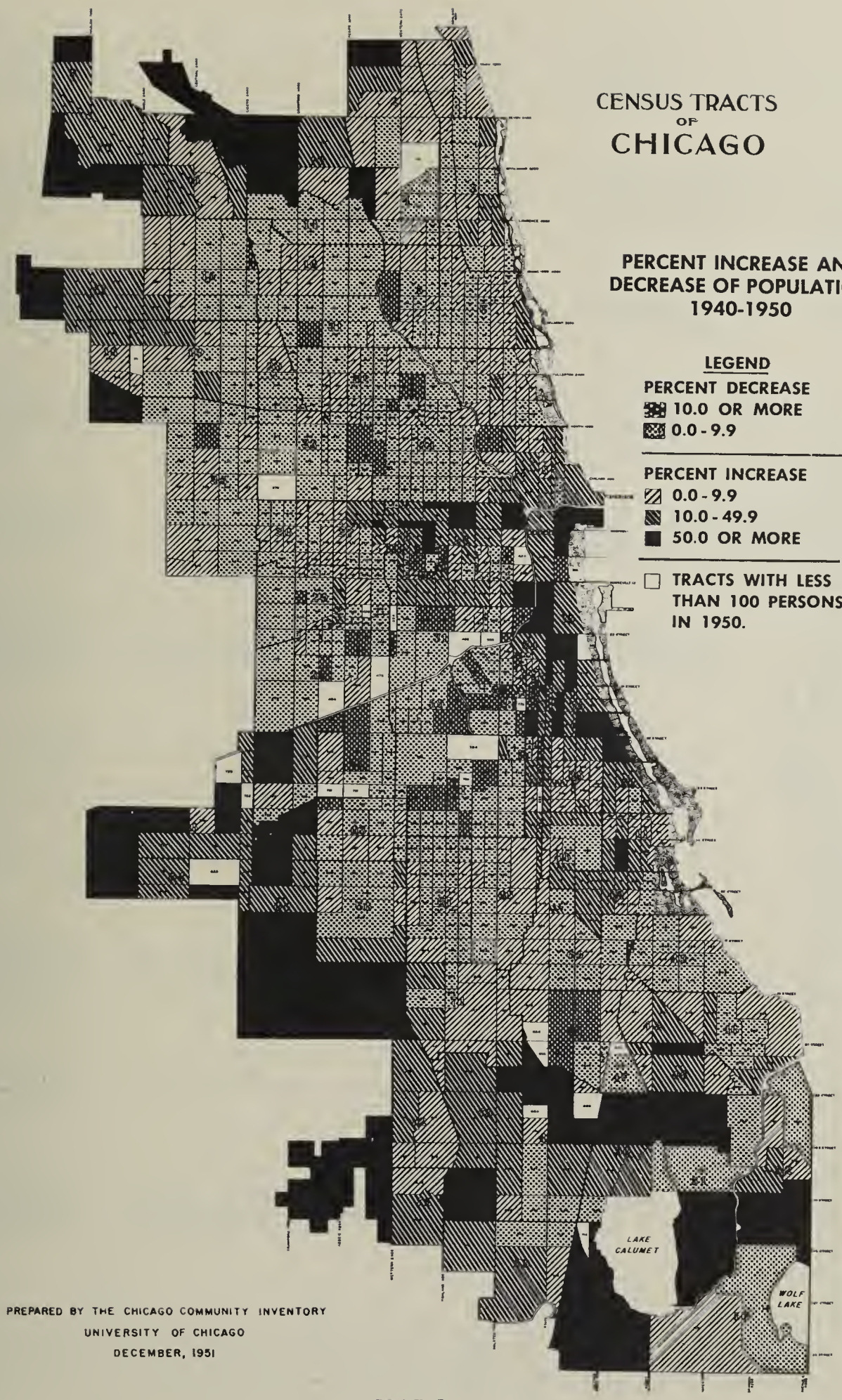
(8) Without much better planning for metropolitan areas than is being done today, a combination of local public, private, state and Federal action like that outlined above might easily produce a mess of tangled, half-done undertakings that would fall far short of the objective. We propose, therefore, that Federal aid be extended to meet some proportion of the costs of the planning process in these areas. For example, if a metropolitan planning unit were organized that represented and was supported in some equitable and adequate fashion by at least

50 per cent of the municipalities (and counties) with a population of 10,000 (5,000?) or more in a metropolitan area, and if the aggregate population of these civil divisions were 75 per cent of the total metropolitan population, the Federal Government would match appropriations to the planning unit dollar for dollar for a period, say, of 5 or 10 years. If the municipalities would agree to give the planning unit veto power on a limited list of major public undertakings or actions within their jurisdictions (that is, they could be authorized over objection by the planning unit only by an extraordinary majority of the local legislative body), or if the planning unit were a part of a multi-purpose, local development body and had similar powers in respect to its program, the Federal aid would be increased to the proportion of 3 to 1. Admittedly, this latter provision would not be a strong inducement in relation to the probable reluctance of many local units to give such power to a metropolitan-wide agency, but its influence would be in the right direction and might be strengthened by a clear recognition of the planning body in the making of all pertinent Federal grants-in-aid.

(9) Finally, quite probably many officials and others in the central cities would dislike a program of metropolitan dispersion and would drag their heels in respect to it. And quite aside from real or fancied damage to the prestige and position of their municipalities, the program might in fact create or at least aggravate some already troublesome problems of municipal finance. No satisfactory resolution of these problems can be expected short of a thorough overhauling of the revenue sources of local government. But if a policy of planned dispersion in the national interest should affect a central city's financial position adversely and materially, it would seem only fair for the Federal Government to minimize these effects for a few years to give the local government a chance to adapt its revenue and expenditures to the new conditions. To invent a reasonably adequate, simple and equitable form of Federal aid for this purpose would take time, patience, and skill. It should be possible, however, to devise some reasonably objective measures (say, of decrease in taxable industrial and commercial space) to which such special Federal aid could be linked.

The policy measures sketched above make up quite a complex set of proposals. The further study of them and of other possible forms of action would have to give more attention than we have to legislative and administrative considerations. Otherwise one or two of the more

promising proposals might lose out because they are linked with another of lesser merit, or the whole set might be beyond the capacity of the available administrative talent. These are possible dangers; we do not think they are very likely on the whole. And against them must be weighed the point we have urged before: a program for dispersion in metropolitan areas is no child's play; no simple formula will accomplish results, avoid controversy and substantial expenditures; it has to be a frontal attack—measures limited to only one kind of land use or to one type of obstacle almost surely will be defeated by the absence of action in closely related sectors. If it is worth attempting, and we believe it is, it must be made a major order of public business and dealt with accordingly.


CENSUS TRACTS
OF
CHICAGO
PERCENT INCREASE AND
DECREASE OF POPULATION
1940-1950
LEGEND
PERCENT DECREASE
10.0 OR MORE
0.0 - 9.9
PERCENT INCREASE
0.0 - 9.9
10.0 - 49.9
50.0 OR MORE
TRACTS WITH LESS
THAN 100 PERSONS
IN 1950.
LAKE
CALUMET
WOLF
LAKE
PREPARED BY THE CHICAGO COMMUNITY INVENTORY
UNIVERSITY OF CHICAGO
DECEMBER, 1951

MAP I

Table 16

Per Cent Distribution Among Types of Localities of the Aggregate of Production Workers in Manufacturing in the United States and in Nine Regions, 1899-1947[1]
(1929 areas)

Year and Region	Principal Cities A	Satellite Cities B	Industrial Peripheries C	Central Counties of Industrial Areas D	Outer Peripheries E	Industrial Areas as a Whole F	Other Cities of 100,000 Population G	Peripheries of G Cities H	Secondary Industrial Counties I	Areas of Secondary Concentration (G+H+I) J	Rest of the Country K
United States											
1947	32.2	2.4	19.8	42.2	9.9	54.4	7.1	1.9	8.7	17.7	27.9
1939	32.0	3.0	20.0	41.9	10.1	54.9	6.5	1.7	9.6	17.8	27.2
1933	33.1	2.6	18.7			54.4	6.7	1.6	10.3	18.6	27.0
1931	35.2	2.9	18.2			56.3	6.9	1.7	9.7	18.3	25.4
1929	35.1	2.9	18.2			56.2	6.9	1.6	9.3	17.8	26.0
1919	36.1	3.6	18.6			58.3	6.3	1.6	8.3	16.2	25.5
1899	39.5	3.7	14.6			57.8	5.9	1.1	8.4	15.4	26.8
New England											
1947	31.0	5.1	38.4	57.0	12.5	74.5			13.0	13.0	12.5
1939	30.0	5.1	38.2	54.8	13.3	73.2			14.1	14.1	12.7
1933	30.3	5.8	36.6			72.7			5.4	15.4	11.9
1931	31.3	6.1	36.1			73.5			14.5	14.5	12.0
1929	31.9	5.9	35.9			73.7			13.8	13.8	12.5
1919	31.5	6.4	35.4			73.3			13.8	13.8	12.9
1899	29.9	7.0	32.4			69.3			15.3	15.3	15.4
Middle Atlantic											
1947	41.6	5.7	27.4	49.7	19.3	74.8	2.7	1.8	8.2	12.7	12.5
1939	41.5	6.9	26.8	49.6	18.6	75.1	2.7	1.4	9.2	13.3	11.5
1933	43.4	6.6	24.2			74.2	2.6	1.2	10.6	14.4	11.4
1931	45.7	6.8	22.5			75.0	2.6	1.3	10.1	14.0	11.0
1929	44.2	7.2	23.9			75.3	2.9	1.4	9.2	13.5	11.2
1919	44.9	8.2	22.3			75.4	2.9	1.3	8.7	12.9	11.7
1899	52.0	7.0	16.2			75.2	2.7	.9	8.3	11.9	12.9

East No. Central												
1947	41.3	.9	19.0	51.1	9.1	61.1	6.4	1.6	8.5	16.5	22.5
1939	41.2	1.2	19.9	52.2	9.0	62.3	6.4	1.4	8.5	16.3	21.5
1933	43.2		18.0			61.2	6.7	1.4	8.3	16.4	22.4
1931	44.5		17.9			62.4	7.0	1.4	8.2	16.6	21.0
1929	45.8		16.8			62.6	6.8	1.4	8.7	16.9	20.5
1919	45.9		17.4			63.3	6.2	1.2	7.4	14.8	21.9
1899	46.8		9.5			56.3	6.0	.8	7.9	14.7	29.0
West No. Central											
1947	42.9		4.6	45.6	2.0	47.6	7.3	1.5	2.3	11.1	41.4
1939	43.5		4.6	46.1	1.9	48.0	6.7	.6	2.2	9.5	42.5
1933	39.9		11.1			51.0	6.8	.5	1.0	8.3	40.7
1931	42.1		10.4			52.5	7.1	.7	1.2	9.0	38.5
1929	41.1		11.0			52.1	7.0	1.0	1.4	9.4	38.5
1919	39.7		10.1			49.8	7.8	1.5	.9	10.2	40.0
1899	43.3		6.2			49.5	5.0	2.6	.4	8.0	42.5
South Atlantic											
1947	7.3[2]		5.1	10.9	1.5	12.4	7.7	1.5[3]	15.9	25.1	62.5
1939	7.9[2]		5.5	11.5	1.8	13.3	7.7	1.4[3]	17.7	26.8	59.9
1933	8.7		5.6			14.3	7.5	2.0	18.1	27.6	58.1
1931	10.1		5.4			15.5	8.8	2.1	16.7	27.6	56.9
1929	10.0		5.6			15.6	8.4	2.1	15.7	26.2	58.2
1919	12.8		5.8			18.6	10.2	2.9	11.5	24.6	56.8
1899	17.5		5.5			23.0	10.6	2.1	8.4	21.1	55.9
East So. Central											
1947	1.4[4]		1.4	1.4		27.8	7.9	2.5	38.2	60.5	
1939	1.6[4]		1.6	1.6		27.8	8.7	2.5	39.0	59.4	
1933						32.0	7.1	2.5	41.6	58.4	
1931						33.0	8.6	2.2	43.8	56.2	
1929						31.7	7.6	1.9	41.2	58.8	
1919						28.6	8.0	1.5	38.1	61.9	
1899						34.5	5.7	.8	41.0	59.0	
West So. Central											
1947						30.7	6.6	8.3	45.6	54.4	
1939						27.0	7.2	7.8	42.0	58.1	
1933						28.0	6.6	9.5	44.1	55.9	
1931						29.8	6.8	9.5	46.1	53.9	
1929						27.1	5.0	9.1	41.2	58.8	
1919						23.0	4.4	6.2	33.6	66.4	
1899						29.4	.8	4.1	34.3	65.7	

Mountain											
1947							26.1	2.2	6.6	34.9	65.1
1939							21.9	3.2	7.4	32.5	67.5
1933							24.0	2.1	6.4	32.5	67.5
1931							24.1	2.0	6.4	32.5	67.5
1929							21.4	2.4	5.7	29.5	70.5
1919							21.1	2.5	6.0	29.6	70.4
1899							26.9	2.3	9.5	38.7	61.3
Pacific											
1947	34.5	.9	27.4	58.8	3.9	62.7[5]	6.1	1.4	3.0	10.5	26.8
1939	35.7	.7	21.4	53.4	4.3	57.7[5]	6.2	1.1	3.6	10.9	31.5
1933	39.8	.5	17.6			57.9	6.7	1.4	4.4	12.5	29.6
1931	39.4	1.2	16.1			56.7	6.9	1.4	3.7	12.0	31.3
1929	37.6	.5	16.2			54.3	6.5	1.3	4.6	12.4	33.3
1919	39.2	.9	13.8			53.9	8.0	1.2	4.0	13.2	32.9
1899	47.0		6.5			53.5	7.7	.7	2.3	10.7	35.8

[1] Figures through 1933 from Daniel B. Creamer, *Is Industry Decentralizing?*, (University of Pennsylvania Press, Philadelphia —1935), pages 10-11.

A — Central cities of 1929 industrial areas.
B — Satellite Cities—cities with more than 100,000 population in 1929 in industrial areas.
C — Remainder of industrial areas—industrial areas as a whole, minus central and satellite cities.
D — Central counties of industrial areas—counties containing the central cities.
E — Outer peripheries—industrial areas minus the central counties and minus satellite cities outside of the central counties.
F — The industrial area as a whole.
G — Other cities of more than 100,000 population in 1929.
H — Peripheries of *G* cities—the rest of their counties.
I — Secondary industrial counties—counties outside of industrial areas and without a city of 100,000 but *with* 10,000 wage earners or more in 1929.
J — Areas of secondary concentration—G+H+I.
K — All the rest.

The phrases *production workers*, *wage earners in manufacturing*, and *wage jobs in manufactures* have been used over the period. With some minor differences in definition they refer to the same kinds of employees.

Percentages given are based on averages for the years.

[2] Figures for the Central City of Wheeling, West Virginia, withheld by Census Bureau—but are included in the Central County (Ohio County) and Wheeling Industrial Area.

[3] Does not include figures for Henrico County, Virginia (Richmond's Periphery)—figures not available.

[4] These figures are for Campbell and Kenton counties, Kentucky, which are parts of the Cincinnati industrial area. Cincinnati and the rest of its area are in the East North Central region. Mr. Creamer's tabulation did not show this inter-regional split. Possibly the volume of industry in these counties was so small before 1933 that he ignored it. It is possible also that the volume before 1933 was so small that Census rules against disclosure prevented the figures for these parts of the Cincinnati area from being published.

[5] This figure includes the production workers in Solano County, which is in the San Francisco standard metropolitan area, but which was not in the San Francisco industrial area. The total of production workers in Solano and Main Counties was 1,600 in 1947 and 995 in 1939. The industrial area had a total of 131,160 production workers in 1947 and 76,044 in 1939.

Table 17

Per Cent Distribution Among Types of Localities of Production Workers in Manufacturing in the United States and in Nine Regions — 1939 and 1947[1]
(1947 areas)

Region	Central Cities A	Satellite Cities B	Metropolitan Peripheries C	Central Counties of SMA's D	Outer Peripheries E	SMA's as a Whole F	Other Cities of 100,000 Population G	Peripheries of G Cities H	Secondary Industrial Counties I	Areas of Secondary Concentration (G+H+I) J	Rest of the Country K
United States											
1947	36.1	2.1	20.0	46.3	9.9	58.2	3.5	.7	11.5	15.7	26.2
1939	35.7	2.6	19.3	45.4	9.6	57.6	3.2	.7	11.9	15.8	26.7
New England											
1947	32.6[2]	2.2	23.9	48.2	8.3	58.8	1.3	[4]	10.4	11.7	29.6
1939	31.4[2]	2.3	20.6	44.2	7.8	54.2[3]	1.5	[4]	11.4	12.9	32.9
Middle Atlantic											
1947	44.2[2]	5.7	30.7	53.7	21.3	80.6	.4	.2	9.2	9.8	9.5
1939	44.0[5]	6.9	29.5	53.6	19.9	80.4	.4	.2	9.5	10.1	9.5
East No. Central											
1947	46.4	.9	19.1	57.9	7.6	66.4	.7	.2	14.4	15.3	18.4
1939	46.4	1.2	19.8	59.0	7.2	67.4	.5	.1	13.9	14.5	16.1
West No. Central											
1947	42.9		5.2	45.6	2.6	48.2	7.3	1.5	4.0	12.8	39.1
1939	43.5		5.1	46.1	2.5	48.6	6.7	.6	3.5	10.8	40.6
South Atlantic											
1947	9.5[6]		6.4	13.5	2.4	15.9	6.3	1.4[7]	23.3	31.0	53.1
1939	10.0[6]		6.7	14.0	2.7	16.7	6.5	1.3	24.8	32.6	50.7
East So. Central											
1947	12.1		7.0	17.8	1.4	19.2	15.7	2.2	8.0	25.9	55.0
1939	11.6		6.8	16.8	1.6	18.4	16.2	3.5	7.3	27.0	54.5
West So. Central											
1947	13.2		5.2	16.5	2.0	18.4	16.6	3.4	6.8	26.8	54.9
1939	13.5		5.1	16.3	2.3	18.6	12.7	4.0	6.0	22.7	58.7
Mountain											
1947							26.1	2.2		28.3	71.6
1939							21.9	3.2		25.1	75.0

Pacific											
1947	36.6	.9	29.6	61.0	6.0	67.1	4.6	1.5	2.1	8.2	24.7
1939	37.4	.7	23.2	54.9	6.4	61.3	5.3	1.6	2.3	9.2	29.5

[1]The figures in Tables 17, 18 and 19 are based on a different breakdown of localities than in Table 16. After World War II a number of agencies of the Federal Government, under the leadership of the Bureau of the Budget, defined 168 *standard metropolitan areas* for the continental U. S. These differ from the earlier *metropolitan districts*. Fifty-three of the largest standard metropolitan areas, i.e., those with 40,000 or more manufacturing employees in 1947, were used in reporting the 1947 Census of Manufactures. These large standard metropolitan areas differ considerably from the 33 *industrial areas* used in earlier Censuses of Manufactures. To quote from section 16 of the General Explanations of the Census of Manufactures for 1947, Vol. I, page 13:

> "... Industrial areas, as defined in previous years, were groups of contiguous counties having large numbers of manufacturing wage earners. The standard metropolitan areas, on the other hand, are integrated economic and social entities which contain not only highly industrialized counties but also adjoining counties which, though primarily residential in character, contribute significantly to the industrial counties' labor force."

The Census' new definition of industrial areas—i.e., "standard metropolitan areas having 40,000 or more manufacturing employees" is shortened to SMA.

Except in New England all SMA's are counties or combinations of counties. In New England they are made up of towns.

Each of the three volumes of the Census of Manufactures for 1947 contains a definition and explanation of SMA's and a list of the SMA's with 40,000 or more manufacturing employees.

In Tables 17 and 18, figures for standard metropolitan areas are compared for the years 1939 and 1947. The other types of localities are based on or derived from either the 1940 Census of Population or the 1947 Census of Manufactures.

A — Central cities of 1947 SMA's.

B — Satellite Cities—cities with more than 100,000 population in 1940 in SMA's.

C — Remainder of SMA's—SMA's as a whole minus central and satellite cities.

D — Central counties of SMA's—the counties containing the central cities. In New England, Central County = SMA, except in the Boston SMA.

E — Outer peripheries—SMA's as a whole minus the central counties and minus satellite cities that are outside of the central counties.

F — SMA's as a whole.

G — Other cities of more than 100,000 population in 1940.

H — Peripheries of *G* cities (the rest of their counties).

I — Secondary industrial counties—counties outside of SMA's and without a city of 100,000 (1940 census) but *with* 10,000 or more manufacturing wage earners in 1947.

J — Areas of secondary concentration—*G*+*H*+*I*.

K — All the rest of the country—not in classes *A*-*J*.

[2]Does not include figures for Bristol, Connecticut.

[3]Does not include a small number of workers who in 1939 worked in the Springfield—Holyoke and Fall River—New Bedford SMA's and for whom figures are not available, as a consequence of SMA's overlapping state boundaries.

[4]Middlesex County workers, by definition, belong in this category. However, part of Middlesex County is contained in the Boston SMA. To avoid double enumeration, those Middlesex County workers not included in the Boston SMA tabulations show up in Column K.

[5]Does not include figures for Rome, New York, nor Easton, Pennsylvania.

[6]Does not include figures for Wheeling, West Virginia, nor Steubenville, Ohio.

[7]Does not include Henrico County, Virginia.

Table 18

Increases in Production Workers in Manufacturing, 1939-1947, as Percentages of Number of Production Workers in 1939 for the United States and Nine Regions by Types of Localities (1947 areas)

Region	Central Cities A	Satellite Cities B	Metropolitan Peripheries D	Central Counties of SMA's C	Outer Peripheries E	SMA's as a Whole F	Other Cities of 100,000 Population G	Peripheries of G Cities H	Secondary Industrial Counties I	Areas of Secondary Concentration (G+H+I) J	Rest of the Country K	Total L
United States	54.5	22.3	58.2	55.6	57.1	54.3	66.0	57.1	47.4	51.6	49.8	52.6
New England	37.0	27.8	53.1	43.8	40.7	42.7	16.4		20.4	19.9	18.3	31.8
Middle Atl.	45.9	19.9	51.1	45.4	54.9	45.6	61.7	123.5	40.3	42.4	45.6	45.3
East No. Cen.	63.5	21.0	57.8	60.3	74.0	61.1	115.1	104.5	69.5	71.4	65.9	63.5
West No. Cen.	67.0		73.2	67.1	77.9	67.7	84.5	292.5	90.2	98.4	62.8	69.1
South Atl.	31.5		30.8	32.4	24.8	31.2	33.8	45.2	29.1	30.6	44.2	37.6
East So. Cen.	63.8		62.5	66.2	33.1	63.3	52.5	(−1.7)	71.0	50.4	58.5	57.2
West So. Cen.	72.0		81.2	77.9	49.7	74.5	130.0	47.7	98.7	107.3	64.7	76.2
Mountain							107.3	21.2		96.3	65.7	73.3
Pacific	77.7	123.9	131.2	101.8	70.3	98.5	56.9	69.1	67.8	61.7	52.2	81.5

For definitions see footnote to Table 17

Table 19

Per Cent Distribution Among Types of Localities of the Dollar Volume of Industrial Construction Contracts July 1, 1945 through June 30, 1949 for the United States and Nine Regions (1947 areas)

Region	Central Cities A	Satellite Cities B	Metropolitan Peripheries C	Central Counties of SMA's D	Outer Peripheries E	SMA's as a Whole F	Other Cities of 100,000 Population G	Peripheries of G Cities H	Secondary Industrial Counties I	Areas of Secondary Concentration (G+H+I) J	Rest of the Country K
United States	24.6	2.0	20.9	35.8	10.3	47.5	8.3	1.1	7.5	16.9	35.6
New England	36.2	6.7	32.2	52.6	15.8	75.1			2.4	2.4	22.5
Middle Atlantic	29.6	6.9	52.6	41.5	40.7	89.1	1.0	.3	4.9	6.2	4.7
East No. Central	40.4	1.1	26.5	57.9	9.0	68.0	2.0		13.6	15.6	16.4
West No. Central	40.0		14.1	53.3	.8	54.1	5.4		3.9	9.3	36.6
South Atlantic	9.3		6.8	10.6	5.5	16.1	22.7	.3	5.7	28.7	55.3
East So. Central	6.3			6.3		6.3	19.5	.2	8.0	27.7	66.0
West So. Central	18.8		6.2	25.0		25.0	7.9	.7	8.2	16.8	58.1
Mountain							20.3	26.0		46.3	53.7
Pacific	19.3	5.3	32.8	44.5	13.0	57.5	8.4	1.7	3.6	13.7	28.8

Source: Data are the dollar volume of industrial construction contracts let (for amounts of $100,000 and more) as reported by the *Engineering News Record* and compiled by the Territorial Information Department.

For explanation of the locality breakdown see footnotes to Table 17

LAND USE POLICY AND STANDARDS OF URBAN DEVELOPMENT IN THE USSR

Appendix V-C
to
Part V of the
Report of

PROJECT EAST RIVER

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by
Maurice Frank Parkins

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A. BRIEF SUMMARY OF THE DEVELOPMENT OF CITY PLANNING IN THE SOVIET UNION

1. INTRODUCTION

According to the Soviets, city planning in the Soviet Union has had three stages: the initial stage, 1922-1931; the second or transitional stage, 1931-1944, which saw a change from trial-and-error method of planning to one based on general national policy and on basic city planning principles, culminating in the general plan for the reconstruction of Moscow, but interrupted by World War II; and the third or reconstruction stage, 1944-1950.

It is not clear that a process which could be termed "planning for cities" or "planning cities" existed before 1922. Nor is it certain at what point the Soviet economy was sufficiently stable to permit it to embark on actual construction either of mass housing or of new cities. In any event, it is certain that city planning became a matter of vital concern in the very first days of the Soviet Union. At the height of the revolutionary years of 1918-1919, groups of specialists in Moscow and Petrograd (now Leningrad) were engaged in the replanning of these two cities. The decrees of the Soviet Government in 1917-1921 on land, on nationalization of industry and on home ownership formed the basis of socialist planning. Following the establishment of Goelro (the State Commission for Electrification) in 1920, the first planned workers' settlements began to appear in the vicinity of large electric stations. In February 1921, the Government set up a State Planning Commission, generally referred to as Gosplan, which is still today the chief planning agency of the Soviet Union.

2. THE INITIAL STAGE OF CITY DEVELOPMENT IN SOVIET RUSSIA (1922-1931)

The initial stage concentrated on the restoration and development of the national economy, the building of workers' settlements, the development of public housing projects in workers' districts of large cities and laying out of new industrial cities. Typical projects completed dur-

[1] For a survey of various aspects of Soviet city planning and housing see Maurice Frank Parkins's, THE DEVELOPMENT OF CITY PLANNING IN SOVIET RUSSIA (unpublished masters' thesis, Massachusetts Institute of Technology, May 31, 1947, to be published soon by the Chicago University Press.)

ing this period were the creation of cities like Magnitogorsk, Stalinsk, Komsomol'sk-on-Amur, and Balkhash, as well as the reconstruction of old centers like Baku and Khar'kov.

The planning work was accomplished by trial-and-error methods. Lacking a definite approach to the problem of populated areas, the Soviet city planners naively adopted foreign theories. During the late twenties, an attempt was made to shape city planning into a political mold. It was Lenin's idea to eradicate that hard and fast line which existed between the city and village, but more specifically, between the indifferent peasant on the one hand and the politically conscious urban proletariat on the other. This principle is reflected throughout the development of Soviet city planning. A corollary of this principle is the one which would equitably distribute the productive forces over the entire country, in conjunction with the location of natural resources, all in accord with a general plan for the development of the country as a whole.

During the initial stage the Soviets admitted having committed many mistakes in their city planning work. According to Soviet authorities, many of the cities were poorly planned, and the plans were loosely executed. The plans for new cities were not related to the physical environment, to the natural conditions such as a river or lake. Embankments and ravines were disregarded within the planned areas. Similar schemes prepared by central offices were applied to large and small cities, to resort towns, and to workers' settlements.

The Soviets attributed the shortcomings of the initial stage basically to the absence of a definite planning policy, the lack of planning principles, insufficiency of technical planning skill, the lack of building materials, and inexperience in construction. Considerable confusion existed as to the major socio-ideological concepts in planning, as for example, the question of whether or not to socialize the family, or what physical form the socialist city should take. Most of these shortcomings were eliminated during the preparation of the general plan for the reconstruction of Moscow in the transitional stage.

3. THE SECOND OR TRANSITIONAL STAGE (1931-1944)

The second stage evolved the concept of the "general" plan (equivalent to our "master plan") for the development of population areas. Since 1935, when the Moscow Plan was officially approved, any new urban development had proceeded only under the authority of a general plan. The two outstanding characteristics of the general plan are its status as a judicial act and its integration into the national economic plan.

The planning experience gained during the Moscow Plan strongly influenced subsequent planning and reconstruction of large Soviet cities such as Kiev, Khar'kov, Baku, Tashkent and Leningrad.

The Moscow Plan greatly improved the physical and esthetic aspects of the city and created many socio-cultural and recreational facilities. It has set a limit for the growth of its population and the spread of the city's boundaries. However, in housing it fell far short of its goals.

During the third Five-Year Plan (1938-1941) the Soviet Government and the Communist Party reaffirmed its earlier policy of 1931 of decongestion by prohibiting the concentration of new industrial plants in existing large cities, and concentrated its efforts on decentralization through regional planning. The Soviet authorities, in setting up this policy, have underscored the ever-conscious problem of national defense; the creation of self-sufficient urban centers in respect to supplies of potatoes, vegetables, milk and meat supply;[2] the dispersion of the thickly populated large cities to the suburbs;[3] and the creation of self-sufficient industrial regions, utilizing local resources and electric power. As a result, many medium and small-sized enterprises as well as large industrial construction began to be distributed over various economic regions of the country; this resulted, in turn, in the growth of a number of new medium and small-sized cities along with the appearance of new large centers and the further penetration of urban settlements into outlying territories. At the same time city planning in the existing centers continued. In 1940 the planners undertook to prepare general plans for the reconstruction of 225 old cities in the Russian Republic alone, which plans did not reach completion on account of the German invasion. The organized resettling of the Far East had begun during the end of the Second Stage (1941); it was realized under express method of construction, utilizing new standdards and local materials.

[2] The Soviet Government decreed that during the third Five-Year Plan all large cities (Moscow, Leningrad, Kiev, Khar'kov, Baku), important industrial centers (Donbas, Kuzbas, Gov'kii) and major cities of the Far East must develop around their areas large potato-vegetable-dairy farms in order to serve fully these centers with potatoes, vegetables and, to a certain extent, with milk and meat. In addition, each city and industrial center named above must develop its own local fishing industry, wherever rivers, lakes and ponds are available.

[3] The third Five-Year Plan emphasized that each large city and industrial center develop its suburban areas to accommodate the potato-vegetable-milk farms, mentioned above, and a number of independent satellites and dormitory towns for the working populaton.

4. THE THIRD OR RECONSTRUCTION STAGE (1944-1950)

The third stage of Soviet city planning has concentrated on the restoration of hundreds of cities and thousands of villages destroyed during World War II. The reconstruction process, begun as soon as the invading forces were driven out of an area, is a resumption of the planning process established during the first Five-Year Plan and continued even during the war period.

General plans have been prepared for the rebuilding of more than 300 cities; most of these plans were approved by the Government. In at least 65 cities reconstruction now proceeds according to planned projects. The first stages for rehabilitation and reconstruction of many cities and numerous villages had been completed by 1950.

The reconstruction process implemented the fourth Five-Year Plan, which was marked by increased industrialization; this was manifested in the mechanization of the building industry, especially in the use of express methods of construction and new building techniques such as prefabrication. Research was advanced in mass construction techniques, labor saving devices, and the use of new types of building materials.

There has developed a more realistic approach to the preparation of planning projects. For instance, instead of designing plans in central project offices hundreds of miles from the building sites, the city planning teams have been sent to the areas being planned in order to study local conditions and consult with local authorities. The concept of planning as a tool of administration, involving the integration of projects with a carefully conceived capital budget program, was fully developed. The organization of the city planning structure and process has taken definite form during the reconstruction period.

Plans were standardized for workers' settlements, superblocks, collective villages, public buildings, public housing projects as well as for single-family dwellings built with private resources for private use. New planning rules and building norms were developed. The supplying of communal facilities and public services as part of the city planning program was further improved.

Typical post-World War II plans follow the generally accepted principles developed in the Moscow Plan of 1935 and those further evolved since then. Some of these principles include: (1) limiting the growth of the city— a consideration in national defense; (2) orienting the city to natural conditions, and utilizing natural features such as river fronts for

city-wide needs; (3) arranging city territory according to land use (industrial, commercial, residential); (4) developing the city center as a political, administrative and social core of the city; (5) reducing the differences between the city and its suburban area; (6) developing the superblock as a basic planning unit of the city; (7) supplying of housing and communal facilities and public services as part of the general plan of the city; (8) utilizing standard designs for housing and public buildings, and applying express methods of construction; and (9) paying attention to national culture and artistic heritage in the reconstruction of old cities.

B. THE URBANIZATION PROCESS OF THE SOVIET UNION

1. GROWTH OF CITIES, 1926-1939

It is commonly recognized by historians that Russia before the October Revolution of 1917 had been a predominantly agricultural country. It is equally well known that under the Soviet regime industrialization and urbanization have progressed very rapidly.[4] While the steady trend in the growth of the urban population was concomitant with the industrialization of the Soviet economy, the urbanization process actually started during the period of the great reforms under Alexander II in the 1860's.[5] This process was halted or reversed during the chaotic years of the civil war following the revolution of 1917, but was resumed in the early twenties.[6] It has continued ever since, but the sharpest increase of the urban population occurred during the period between 1926 and 1939.

[4] Nikolia A. Voznesenskii, THE ECONOMY OF THE USSR DURING WORLD WAR II, (Washington, D.C.: Public Affairs Press, 1948, p. 13; see also Alexander Baykov, THE DEVELOPMENT OF THE SOVIET ECONOMIC SYSTEM, (New York: The Macmillan Co., 1948).

[5] BOL'SHAIA SOVETSKAIA ENTSIKLOPEDIIA (The Great Soviet Encyclopedia), Vol. 19, (1930), col. 86.

[6] In 1917, the urban population within the USSR territory was about 20,000,000; by 1920 it had dropped to 16,000,000; in 1928 it rose to 17,000,000; and by 1926 the urban population reached 21,000,000. (B.B. Veselovskii, KURS EKONOMIKI I PLANIROVANIIA KOMMUNAL'NOGA KHOZIAISTVA (Course of Economics and Planning of Municipal Economy), (Moscow-Leningrad: Izdatel'stvo Narkomkhoza RSFSR, (1945), p. 137).

Table 1. Growth of Urban Population of the Soviet Union, 1897 — 1939*

Years	Total Pop. Within USSR Territory in Millions (a)	Urban Pop. in Millions	Urban Pop. As Percentage of Total Pop.
Census of Feb. 9, 1897	125.6 (b)	15.8	14.8
Estimate for Jan. 1, 1914	139.3	24.7	17.7
Census of Dec. 17, 1926	147.0	26.3	17.9
Census of Jan. 17, 1939	170.5 (c)	55.9	32.8

*Bol'shaia Sovetskaia Entsiklopediia, Soiuz Sovetskikh Sotsialisticheskikh Respublik, (Moscow: 1947), col. 62.

(a) B.B. Veselovski, Op. Cit., p. 130.

(b) S.S. Balzak, V.F. Vasiutin and Ia. G. Feigin, Economic Geography of the USSR (translated from the Russian by R.M. Hankin and O.A. Titlebaum), (New York: The Macmillan Co., 1949), p. 517.

(c) Including the territory acquired in 1939-1940, the total population of the USSR in 1939 was 193,000,000 persons.

The growth of the urban population in the Soviet Union took place not only in existing cities but also as a result of the appearance of a large number of new cities. Such cities as Magnitogorsk (145,900 inhabitants), Karaganda (165,900), Stalinogorsk (76,200), Komsomol'sk-on-Amur (70,700), and many others, did not even exist on the geographic map in 1926.[7] Between 1926 and 1939 the number of Soviet cities of more than 100,000 population increased from 31 to 82, as is shown by Table 2.

Table 2. Population of USSR Cities of 100,000 or More inhabitants by the Census of 1926 and 1939, Estimates for 1950 and Proposed (Planned) Population Limits of Selected Soviet Cities*

Cities	Population (In Thousands)			
	1926 Census	1939 Census	1950 (a) Estimates	Proposed (Planned) Pop. Limits of Selected Cities (b)
1. Moscow	2,029	4,137	5,100	5,000
2. Leningrad	1,690	3,191	3,300	3,500

Ia. P. Levchenko, Planirovka Gorodov, Tekhniko-Ekonomicheskie Pokazateli i Raschety (City Planning, Technical-Economic Indices and Estimates), (Moscow: Izdel'stvo Akademii Arkhitektury, 1947), p. 8, cites 1939 census figures.

Cities	Population (In Thousands)			
	1926 Census	1939 Census	1950 (a) Estimates	Proposed (Planned) Pop. Limits of Selected Cities (b)
3. Kiev	514	846	900	1,200
4. Khar'kov	417	833	under 900	1,100
5. Baku	453	809	over 600	--
6. Gor'kii	222	644	over 600	--
7. Odessa	421	604	under 600	--
8. Tashkent	324	585	under 600	--
9. Tbilisi	294	519	under 600	--
10. Rostov-on-Don	308	510	over 300	600
11. Dnepropetrovsk	237	501	over 300	--
12. Stalino	174	462	abt. 300	--
13. Stalingrad	151	445	abt. 300	650(c)
14. Sverdlovsk	140	426	under 600	--
15. Novosibirsk	120	406	under 600	750
16. Kazan'	179	401	---	--
17. Kuibyshev	176	390	---	--
18. Saratov	220	376	---	--
19. Voronezh	122	327	---	450
20. Iaroslavl'	114	298	---	--
21. Zaporozh'e	56	289	---	--
22. Ivanovo	111	285	---	--
23. Arkhangel'sk	77	281	---	475
24. Oxsk	162	281	abt. 600	--
25. Cheliabinsk	59	273	---	800
26. Tula	155	272	---	--
27. Molotov	120	255	---	--
28. Astrakhan'	184	254	---	--
29. Ufa	99	246	---	--
30. Irkutsk	108	243	---	--
31. Makeevka	79	240	---	--
32. Minsk	132	239	---	--
33. Alma-Ata	45	231	---	--
34. Mariupol'	64	222	---	--
35. Kalinin	108	216	---	300
36. Voroshilovgrad	72	213	---	--
37. Vladivostock	108	206	---	--
38. Krasnodar	162	204	---	270
39. Erevan	65	200	---	--
40. Khabarovsk	52	199	---	--
41. Krivoi Rog	38	198	---	--
42. Krasnoiarsk	72	190	---	475
43. Taganrog	86	189	---	250
44. Izhevsk	63	176	---	--
45. Chkalov	123	173	---	--

Cities	Population (In Thousands)			
	1926 Census	1939 Census	1950 (a) Estimates	Proposed (Planned) Pop. Limits of Selected Cities (b)
46. Groznyi	97	172	- - -	260
47. Stalinsk	4	170	- - -	- -
48. Vitebsk	99	167	- - -	- -
49. Nikolaev	105	167	- - -	- -
50. Karaganda	- -	166	- - -	- -
51. Nizhnii Tagil	39	160	- - -	- -
52. Penza	92	157	- - -	- -
53. Smolensk	79	157	- - -	200
54. Shakhty	41	155	- - -	- -
55. Barnaul	74	148	- - -	- -
56. Kneprodzerzhinsk	34	148	- - -	- -
57. Magnitogorsk	- -	146	- - -	- -
58. Gomel'	86	144	- - -	- -
59. Kirov	62	143	- - -	- -
60. Simferopol'	87	143	- - -	- -
61. Tomsk	92	141	- - -	- -
62. Rybinsk	56	139	- - -	- -
63. Samarkand	105	134	- - -	- -
64. Kemerovo	22	133	- - -	400
65. Poltava	92	130	- - -	- -
66. Ulan-Ude	29	129	- - -	- -
67. Ordzhonikidze	78	127	- - -	- -
68. Ashkhabad	52	126	- - -	- -
69. Tambov	72	121	- - -	- -
70. Kostroma	74	121	- - -	- -
71. Kursk	82	120	- - -	200
72. Murmansk	9	117	- - -	- -
73. Sevastopol'	75	112	- - -	200
74. Orel	76	111	- - -	300
75. Semipalatinsk	57	110	- - -	- -
76. Gorlovka	23	109	- - -	- -
77. Prokop'evsk	11	107	- - -	190
78. Kerch'	54	104	- - -	140
79. Dzerzhinsk	9	103	- - -	- -
80. Chita	62	103	- - -	- -
81. Ul'ianovsk	70	102	- - -	400
82. Kirovograd	66	100	- - -	- -
(c)				
A Riga	- -	385	- - -	500
B Vil'nius	- -	215	- - -	300
C Kishenev	- -	188	- - -	200

Cities	Population (In Thousands)			
	1926 Census	1939 Census	1950 (a) Estimates	Proposed (Planned) Pop. Limits of Selected Cities (b)
D Kaunas	--	152	---	220
E Tallin	--	146	---	320

* N. Kh. Poliakov, SPRAVOCHNIK ARKHITEKTORA, TOM II, GRADOTEL'STVO (Architect's Handbook, Vol. II, City Planning) (Moscow: Izdatel'stvo Akademii Arkhitektury SSSR, 1946), pp. 48 - 51.

(a) Harry Schwartz, RUSSIA'S SOVIET ECONOMY (New York: Prentice-Hall Inc., 1950), p. 32. Refers to calculations based on elections district data published in PRAVDA, January 12, 1950.

(b) The population limits for the selected cities cited in this column were based on proposed long-range plans of development of these cities which were prepared and approved after World War II.

(c) A-E, cities absorbed by the USSR since the 1939 census.

In number of such cities the Soviet Union has overtaken other countries and is now second only to the United States,[8] as seen from the following table:

Table 3. Cities of 100,000 or More Population in Major Countries of the World, 1926–1939*

Country	1926 Number of Cities	1939 Number of Cities
USA	80	94(a)
USSR	31	82
Great Britain	51	58
Germany	45	57
Italy	18	22
France	17	17

* B.B. Veselovskii, OP. CIT., p. 129

(a) The U. S. Department of Commerce, Bureau of the Census, 1950 CENSUS OF POPULATION, PRELIMINARY COUNTS, (Washington, D.C.: December 8, 1950) lists only 92 cities of this size in 1940.

[8] Mark Jefferson, "Distribution of the World's City Folks: A Study in Comparative Civilization," GEOGRAPHICAL REVIEW, Vol. 21 (1931), pp. 446-465. The most authoritative recent map of cities of more than 100,000 population is by Clarence B. Odell (WORLD: CITIES OF 100,000 AND OVER, 1:75,000,000 U. S. Dept. of State, Office of the Geographer, Preliminary printing, May, 1943). For the United States, see C.D. Harris, "The Metropolitan Districts in 1940", JOURNAL OF GEOGRAPHY, Vol. 41 (1942), pp. 340-343.

The rapid growth of Soviet cities in the period from 1926 to 1939 is unparalleled in the earlier history of Russia or in the city development of other countries. The urban population in the Soviet Union more than doubled in this 12-year period.[9] A comparable growth in the United States required about 31 years (1856-1887).[10]

The Soviet Union is now becoming a country of great cities. Moscow, with an estimated population of more than 5 million inhabitants, and Leningrad, with more than 3.5 million, are among the great cities of the world.[11] High percentages of increase in population characterize most of the large cities in the USSR, as well as most smaller urban communities within the 1939 boundaries.[12] There were 12 cities with more than 200,000 inhabitants in 1926, including Leningrad and Moscow.[13] In 1939, there were 39 cities over the 200,000 mark, including Moscow and Leningrad. These cities had a combined population of 13,557,000 persons in 1939, a figure 90 per cent above their combined population in 1926. The high increases in these cities were largely due to the rapid development of their industries or the supply of new power. Of these cities, Gor'kii, northeast of Moscow, the Detroit of the Soviet Union, increased in 12 years from 222,000 to 644,000. The increase in population in the national capital of Moscow during this intercensal period was 2,108,000 inhabitants, approximately equivalent to 1,740,000 in a decade.

The rapid growth of the national capital of Moscow and of the capitals of the republics is indicated by the general expansion of administrative centers of the USSR. Thus Kiev, capital of the Ukranian Republic, has increased by 65 per cent; Baku, capital of the Azerbaidzhan SSR, 79 per cent; Tbilisi, capital of the Georgian SSR, 77 per cent; Tashkent, capital of the Uzbek SSR, 81 per cent. Such cities are centers for not only administrative activities, but also for a variety of industrial, commercial and cultural activities. Some of the smaller capital cities of other republics

[9] Unless otherwise noted, all 1926 and 1939 population figures for the Soviet Union are from PLANOVOE KHOZIAISTVO (Planned Economy), No. 6, 1939, pp. 14-17.
[10] Comparative figures are based on SIXTEENTH CENSUS OF THE UNITED STATES, 1940: POPULATION, Vol. 1. Number of Inhabitants, Table 12, pp. 32-33.
[11] Harry Schwartz, OP. CIT., p. 32.
[12] According to one official Soviet definition, an urban community is classified as a city if (1) more than half of the population is engaged in non-agricultural pursuits, and if (2) at least 500 inhabitants are employed in industry or 2,000 in commercial undertakings. (Parkins, OP. CIT., p. 3, refers to V.V. Anisimov and N.A. Kokovin, KOMMUNAL'NAIA STATISTIKA (Municipal Statistics), (Moscow-Leningrad: Izd-vo. Ministerstva Kommunal'nogo Khoziaistva RSFSR, 1947), p. 291; see also MALAIA SOVETSKAIA ENTSIKLOPEDIIA, Vol. 3, p. 352.
[13] These cities are (in order of population, 1939): Moscow, Leningrad, Kiev, Khar'kov, Baku, Odessa, Tashkent, Tbilisi, Rostov-on-Don, Dnepropetrovsk, and Saratov.

show even more conspicuous increases. The city of Erevan, capital of the Armenian Republic, increased by 210 per cent; Alma-Ata, capital of the Kazakh SSR, increased by 408 per cent.

Along with the rapid growth of administrative centers, there was a movement of population into their suburban areas. Several of the suburbs around Moscow increased threefold and more during the 12-year period. For example, the suburban places of Moscow grew from about 10,000 persons in 1926 to cities of over 60,000 in 1939. A similar trend in growth was reported for suburbs of Leningrad and other large cities of the Soviet Union.[14]

According to official Soviet information, the growth of the urban population during the period between 1926 and 1939 resulted from the following:[15]

1)	"Organized resettlements," migration from rural to urban areas	18.5 million
2)	Natural increase, i.e. the excess of births over deaths	5.3 million
3)	Reclassification of rural places into urban communities as the result of their growth or changed economic function	5.8 million
	TOTAL	29.6 million

2. GROWTH OF WORKERS' SETTLEMENTS[16]

In addition to the rapid growth of cities in the Soviet Union during the intercensal period of 1926 and 1939, there occurred an equally rapid rise in the number of workers' settlements. This trend may be seen from the data given for RSFSR during a similar period.

[14] Frank Lorimer, THE POPULATION OF THE SOVIET UNION: HISTORY AND PROSPECT, (Geneva: League of Nations, 1946), p. 146.

[15] Levchenko, OP, CIT., p. 130.

[16] To date there is no clearly defined term for "settlement" in Soviet literature. It is a matter of legal definition (actually determined by its economic function) and does not strictly imply any specific size or density. A settlement has been called a workers' settlement; railroad, resort or summer settlement; sovkhoz (state farm) settlement; settlement of city-type; mixed settlement; and settlement in general. In some cases, railroad settlements, settlements of sovkhozy and city-type settlements are classified as workers' settlements; in other cases, they are not. For planning purposes, Levchenko defines a settlement as a populated place having a population of not more than 20,000 inhabitants. (IBID., p. 9.)

Table 4. Growth of Workers' Settlements in the RSFSR, 1925-1940*

Years	1925	1927	1933	1937	1940
Number of Settlements	9	57	354	494	786

*Ia. P. Levchenko, TECHNIKO-EKONOMICHESKIE OSNOVY PLANIROVKI POSELKOV (Technical-Economic Bases for Planning Settlements), (Moscow: Izd-vo Akademii Arkhitektury, 1944), p. 5.

The 1939 census listed a total of 1,500 workers' settlements and settlements of city-type in the USSR.[17] This figure includes newly built settlements as well as previously existing settlements which according to their population composition belonged to the category of workers' settlements.

3. DISTRIBUTION OF SOVIET CITIES

The Soviet cities, as listed in the 1939 census, are here grouped according to size of population (Table 5):

Table 5. Population in Groups of Cities Classified According to Size, 1939*

Size of City (a) (in thousands)	No. of Cities	Population	
		In Millions	Percentage
Up to 50	2,196 (b)	22	39.0
From 50 to 100	92	7	12.5
From 100 to 300	63	11	19.7
From 300 to 500	8	3	5.4
From 500 to 1,000	9	6	10.7
More than 1,000	2	7	12.5
TOTAL	2,370	56	100

* Levchenko, PLANIROVKA GORODOV, OP. CIT., p. 8.

(a) THE BOL'SHAIA SOVETSKAIA ENTSIKLOPEDIIA (1947), col. 64, lists the following cities arranged by groups according to size in 1939: more than 50,000 pop.—174; more than 100,000—92; more than 250,000—28; and for cities of more than 500,000 pop. the number was 11 This represents a total of 305 cities of 50,000 or more inhabitants in 1939.

(b) According to Levchenko, there was a total of 1,500 workers' settlements and city-type settlements in the USSR in 1939. If this figure (1,500) is subtracted from 2,196 (which represents cities and settlements [workers' settlements and settlements of city type] of up to 50,000 persons) the remainder of 696 would represent urban communities classified as cities of up to 50,000 persons. (Levchenko, TEKHNIKO-EKONOMICHESKIE OSNOVY PLANIROVKI PESELKOV [Technical-Economic Bases for Planning Settlements], OP. CIT., p. 5.)

[17] IBID., p. 5.

From the above data it is evident that nearly 40 per cent of the total urban population of the Soviet Union is distributed in small cities with a population of up to 50,000 inhabitants.

Of interest also are the data given below which show the relative sizes and the character of growth of small, medium and large cities of the USSR during the last half century (Table 6).

Table 6. Distribution of Cities by Size of Population, 1897-1939*

Size of City (in thousands)	Population (in percentages)			
	1897 (Census)	1910	1926 (Census)	1939 (Census)
More than 100	35.1	31.6	43.3	48.3
From 20 to 100	34.5	37.9	35.8	
Up to 20	30.4	30.5	20.9	51.7
	100	100	100	100

* Levchenko, PLANIROVKA GORODOV . . . , OP. CIT., p. 9.

The above table shows, along with the total growth of the urban population since 1926, the characteristic increase of the total population of large cities, whereas previous to 1926, the urban population was distributed more or less evenly among the large, medium and small cities.

On the eve of World War II, the real pattern of the Soviet population revealed the persistent force of natural conditions (climate, topography, and distance). Large areas remained uninhabited or were sparsely settled. However, during and since the war many important industrial cities were also developed in the periphery of the population centers. Cities in the Urals and east of the Urals like Sverdlovsk, Novosibirsk and Omsk have had phenominal increases in their population (Table 2). A similar trend is indicated for cities in Soviet Asia during the 1939-1944 period, as seen from Table 7:

Table 7. Growth of Cities in Soviet Asia, 1939-1944*

City	1939	1944	Increase	Percent Growth
Komsomol'sk-on-Amur	71,000	127,000	56,000	79
Khabarovsk	199,000	250,000	51,000	25
Chita	133,000	170,000	67,000	65
Ulan-Ude	129,000	150,000	21,000	16

City	1939	1944	Increase	Percent Growth
Irkutsk	243,000	300,000	57,000	23
Krasnoiarsk	190,000	300,000	110,000	59
Novosibirsk	406,000	600,000	194,000	48

*Schwartz, OP. CIT., p. 33, cites data given Henry Wallace during his 1944 visit to Soviet Asia (Henry Wallace, SOVIET ASIA MISSION, p. 64).

From the data cited it may be seen that during and since World War II, the population of Soviet cities has continued to increase still further. As the utilization of natural resources, industrial power, commerce and transportation continue to increase in the future, the trend toward urbanization appears likely to continue. By January 1, 1947, according to one source, there were 1,380 cities and 1,942 settlements of city type in the Soviet Union.[18]

With a few exceptions, the Soviet cities are distributed throughout one-fifth of the territory of the USSR. This part of the country coincides with the ecumene, or inhabited area, having more than 10 rural inhabitants per square kilometer. This ecumene consists of four parts: (1) A broad triangle having its base along the western frontier of the Soviet Union from a point near Leningrad on the top to the Black Sea on the south. It extends to the southeast in a narrow ribbon just beyond the Ural Mountains; (2) a band along the northern slopes of the Caucasus; (3) a narrow ribbon along the Trans-Caucasian Railway system, starting east of the Urals and stretching to the Pacific coast. (It widens into a pocket near the city of Novosibirsk and includes the Kuzbas industrial area and the agricultural areas southward); and (4) a strip bordered by desert in Central Asia along the rivers Amu Daria, Syr Daria, Zerevshan and other streams which have their source in the Tian-Shan and Pamir Mountains and which irrigate the oases.

Within this inhabited area the spacing of cities is affected by three factors: first, by the alignment of urban centers along transportation lines (land and water); secondly, by the grouping of industrial centers in the four industrial districts; and finally, by the suburban development near large cities such as Moscow and Leningrad.

The remaining four-fifths of the country consists of large wastelands without any important urban or rural settlements. South of the Trans-Siberian Railroad are dry steppes and deserts of Southeastern Europe and Central Asia; to the north the summers are cool and short, and the

[18] BOL'SHAIA SOVETSKAIA ENTSIKLOPEDIIA, 1947, OP. CIT., col. 63.

ground is poorly drained. Of the 187 cities of more than 50,000 persons only nine are located outside the inhabited area.[19]

These are the Arctic ports of Murmansk and Arkhangel'sk and the Caspian port of Astrakhan; Karaganda, the largest new city in the Soviet Union located in the north-central part of the Asiatic steppes and center of new coal mining operations; Magnitogorsk, the second largest new city, in the southern Urals and the site of a new metallurgical center; Ural'sk and Semipalatinsk, near the borderlands between farming and livestock herding; Petropavlovsk, on the Trans-Siberian Railroad; and Komsomol'sk-on-Amur, a new city built in the wilderness of the Soviet Far East.

Within the ecumenical area of the Soviet Union the percentage of urban population shows marked variation from one region to another. We have seen that for the country as a whole the figure is 32.8 per cent. But in political units where the cities are only local centers, commerical or political concentrations, the urban population is usually less than 30 per cent, sometimes even less than 20 per cent. On the other hand, in political units with ports and industrial centers of more than local significance, the urban population is more than 40 per cent, and sometimes as high as 50 per cent.

The growth of Soviet cities took place primarily in the industrial areas of the Ukraine, the Urals, and the Kuzbas as well as along the Turkish border, west of Alma-Ata and in the Moscow suburbs. In fact, urbanization in the USSR was part of the industrialization carried out during the Five-Year plans. In the period between the two censuses of 1926 and 1939, the median rate of increase of the urban population was 184 per cent for the industrial centers, as compared with 69 per cent increase for the trade and diversified cities. The connection between urbanization and industrialization is further attested by the growth of the urban population in the eastern regions of the USSR during and since World War II. The urban population there has increased from 15.6 million at the beginning of 1939 to 20.3 million at the beginning of 1943.[20] Vosnesenskii attributes this to the development of industry in those regions during the war.[21]

[19] See Bol'shai Sovetskii Atlas Mira (The Great Soviet World Atlas), Vol. I, (Moscow: 1938).

[20] N.A. Vosnesenskii, op. cit., pp. 27-28.

[21] ibid.

4. FUNCTIONAL CLASSIFICATION OF MAJOR SOVIET CITIES

Among the 82 Soviet cities of 100,000 or more inhabitants four major types can be distinguished:

Industrial	36
Transportation	20
Trade	9
Diversified	17

a. Industrial Cities.

All cities having an industrial production value of more than 1,500 rubles per capita in 1935 are classified as industrial cities.[22] The principal cluster of industrial centers are in the Central Industrial District, in the Ukrainian Industrial District, and in the Kuzbas Industrial District. In the Urals the manufacturing is carried on in towns of less than 100,000 inhabitants. The larger cities are railroad and diversified centers.

b. Transportation Cities.

Transportation cities are those centers where more than 18 per cent of the population are gainfully occupied in transportation, or more than 15 per cent of persons are gainfully occupied in railroads alone (1926 census). In the Soviet Union such centers assume great importance. Two important transportation centers are Murmansk in the north and Vladivostok in the far east.

c. Trading Cities.

The trading cities are located mainly along southeastern fringes of Central Asia. Four of them are administrative-political centers: Erevan of the Armenian Republic, Tashkent of the Uzbed SSR, Alma-Ata of the Kazakh SSR, and Ulan-Ude of the Buriat-Mongolian ASSR. The other trading centers are Ordzhonikidze, Smolensk, Samarkand, Semipalatinsk and Tomsk.

d. Diversified Cities.

Diversified centers are cities which have industry, but not of a dominant role, and where transportation is also of a secondary function. These cities are largely distributed in the European USSR but outside the in-

[22] For values of industrial production in each city in 1935 (prices as of 1926-19267) for individual industries and total for all industries, see BOL'SHOI SOVETSKII ATLAS MIRA (The Great Soviet World Atlas), OP. CIT.; among the industrial cities 13 are closely connected with mining. The main centers of the oil industry are Baku and Groznyi in the Caucasus. The major coal mining cities are Shakhty in the Donbas, Prokop'evsk in the Kuzbas and Karaganda in the Kazakh SSR. The chief centers of the fuel-oriented, metallurgical and chemical industries are Stalino, Makeevka and Gorlovka in the Donbas; Stalinsk and Kemerovo in the Kuzbas. (IBID.)

dustrial districts. They are centers of large surrounding areas. Among such centers are Kiev and Odessa occupying large sections of the Ukraine, Minsk in White Russia, Simferopol' in the Crimea, Rostov-on-Don in the lower Don River region, Sverdlovsk in the Urals, Novosibirsk in Western Siberia, and Tbilisi in Transcaucasia.

5. TRENDS

As Soviet industrial power, commerce, and transportation activity continue to increase in the future, the trend toward urbanization appears likely to continue. According to Schwartz, the urban population in 1950 may well have reached over 40 per cent of the total USSR population, as against 32.8 per cent in 1939.[23]

Moreover, the Soviet population is, and for some decades will continue to be, an extremely young population in the sense of having a large population of children and young adults and a small proportion of older adults. Very interesting information is available in regard to the age groups of the population of the Soviet Union, as is indicated by the following table:

Table 8. Age Structure of Soviet Population (Jan. 17, 1939)*

Age Groups	Population (in millions)	Per cent of Total
up to 7	31.4	18.6
8-11	16.4	9.7
12-14	13.3	7.9
15-19	15.1	8.9
20-29	30.6	18.0
30-39	25.3	14.9
40-49	15.2	9.0
50-59	10.9	6.4
60 and over	11.1	6.6
TOTAL USSR	1,695	100

*S. Sul'kevich, TERRITORIA I NASELENIE USSR (Territory and Population of the USSR), (Leningrad: Politizdat, 1940), p. 12.

The above figures show a strikingly small percentage of people above 60. The percentage of young people is rather high.

[23] Schwartz, OP. CIT., p. 33.

This situation will presumably change consistently and fairly rapidly during the coming decades. A gradual maturing of the population, with an increasing proportion of older persons, may be expected in the USSR as in most other countries.[24]

C. POLICIES WITH REGARD TO RELATIONSHIP BETWEEN URBAN AND RURAL AREAS

A fundamental principle in the Soviet Union is the abolition of any difference between the urban proletariat and the rural one; the effectuation of this principle is closely related with problems of city development. The Soviets believe that the detachment and, under certain points of view, the antagonism which exists between the city and country is based solely on the distribution of the population and that only a distribution based on principles of uniformity as well as the symbiotic union between industry and agriculture may reach this goal: bringing the "mujik" out of the state of isolation in which he has been living for centuries. In this manner, the causes which gave way to that tremendous attraction of population movement toward big cities and which generated the phenomenon of urbanization would be generally eliminated.

The Soviet Government, as part of its large-scale program of industrialization, agriculture and social development, set out to solve this complicated problem. The elimination of the breach between city and country became one of the earliest principles underlying Soviet city planning.[25] General statements in the writings of Marx and Engels served as early theoretical guides. The aim of Marx and Engels was to distribute heavy production over the entire country according to a single general plan.[26] This was emphasized by Kaganovich in his speech before the June 1931 Plenum of the Central Committee of the All-Union Communist Party[27]:

[24] Lorimer, OP. CIT., p. 144.

[25] Parkins, OP. CIT., p. 8.

[26] V. G. Davidovich, PLANIROVKA GORODOV, INZHENERNO-EKONOMICHESKIE OSNOVY, (Planning of Cities, Engineering-Economic Bases), (Moscow-Leningrad: Izdatel'stro Kommunal'nogo Khoziaistva RSFSR, 1947), p. 23.

[27] L. M. Kaganovich, ZA SOTSIALISTICHESKUIU REKONSTRUKTSIIU MOSKVY I GORODOY SSSR (For the Socialist Reconstruction of Moscow and the Cities of the USSR), (Moscow-Leningrad: "Moskovskii Rabochii", 1931), p. 73.

> "We are moving towards the liquidation of the differences between the city and village, not on the basis of liquidating the cities, but on the basis of changing their appearance and of socialist rebuilding of the village and raising it to a level of the highest culture of the city."

It soon became obvious, however, that to solve this problem changes must take place on both sides: a rational distribution of industry closer to raw materials and a mechanization of agriculture. Many of these changes were accomplished during and since the Five-Year Plans. Considerable progress was also achieved in improving the general transportation system of the Soviet Union, and in providing rural places with electricity, better health conditions, and educational and socio-cultural facilities.[28]

The elimination of the differences between the city and the village has been accentuated since 1950. Under the new policy of amalgamating collective farms, the campaign started for the final liquidation of peasantry as a class and for the transformation of collective farms into agricultural settlements or *agro-cities*.[29] The process has begun; it may still be delayed or deflected, but under the present regime it cannot be stopped.[30]

Thus we can see the significant change in the rural community that the early Marxian theory of city planning—eliminating the differences between the city and village—which the Soviets incorporated into their body of city planning principles intensified with the amalgamation of collective farms. This process will lead to increasing relative importance of state property and of public economy and will manifest itself in new concepts and new forms of city development.

[28] Veselovskii, OP. CIT., p. 117.

[29] VOPROSY EKONOMIKI (Problems of Economics), published by the Economics Institute of the USSR, Academy of Science, No. 10, (Moscow: 1950), pp. 99-108.

[30] See J. J. Bernal, "The Developments of Soviet Science," ANGLO-SOVIET JOURNAL, Vol. XII, No. 3, (Autumn 1951), pp. 8-12.

D. CONTROL, CITY SIZE AND CITY POPULATION POLICY, METHODS AND ACCOMPLISHMENTS

The difficulties arising from the uncontrolled growth of a city sprang from specific local conditions and were closely related to planning. On the other hand, the necessity to use all human resources made itself felt. In many regions of the Soviet Union traditional peasant handicrafts had developed particular skills, and determined the location of factories using these skills. Skilled industrial workers and specialists were largely concentrated in the old centers, particularly Moscow and Leningrad, and were reluctant to move. The Soviet leaders tried to keep the growth of large cities within reasonable limits, but they did not attempt to freeze it. At the end of the first Five-Year Plan, after the great new plants of Moscow and Leningrad had trained millions of new workers, and after the new industrial nuclei had outgrown their difficult pioneer stage, industries dependent on experienced employees could be decentralized and new industrial regions opened up.

The first decision of the Party and the Government to curtail construction of new industrial enterprises in existing centers and to decentralize industries was made at the Plenum of the Central Committee of the Communist Party June, 1931.[31] The Plenum also proposed to disconnect development of new factories in Moscow and Leningrad, beginning with 1932, and set an upper limit of five millions for the growth of Moscow.[32]

Professor S. E. Chernyshev, Chief City Architect of Moscow, in his report to the First All-Union Congress of Soviet Architects held in Moscow in 1937 summarized the basic conditions of the new Moscow plan of 1935 as follows:[33]

> "For the first time in the history of cities we are indicating a definite limit to the spread of the city, depending on the planned forecast of the number of population, the density of the inhabitants and the topographic and other natural condi-

[31] Davidovich, OP. CIT., p. 23.

[32] A. V. Bunin, N.Kh. Poliakov and V. A. Shkvarikov (ed.), GRADOSTROITEL'STVO (City Planning), (Moscow: Izdatel'stvo Academii Arkhitektury SSSR, 1947), p.300.

[33] S. E. Chernyshev, GENERAL'NYI PLAN RECONSTRUKTSII MOSKVY I VOPROSY PLANIROVKI GORODOV SSSR (The General Plan for the Reconstruction of Moscow and Problems of Planning USSR Cities), (Moscow: Izd-vo. Vsesoiuznoi Akademii Arkhitektury SSSR 1937), p. 3.

tions for living, working and the socio-cultural development of the population."

One of the means was already supplied to them by the June Plenum of 1931, which decreed against new influxes of workers by limiting industries in already established industrial centers. Certain other positive checks were employed to limit the number and density of population and to guide the development of the size and shape of the city territory. In the Moscow plan the Soviet planners proposed to ring the city with a 10-mile green circumscription (green belt), and to zone the city territory for specific uses and activities best suited to the land and people.[34] The Moscow Soviet (Council) instructed the housing managers to accept no new tenants who were not employed, and the managers of factories and offices were bound to hire no employees who could not show that they were registered as tenants. Still the city kept growing at almost the same rate as did the urban population generally, and was only little short of the 5,000,00 limit at the outbreak of World War II.[35] However, sudden influxes through the establishment of new industries were stopped. The development of the suburban areas around large cities with satellite towns having their own local economy (employment) and with dormitory towns for many city workers was part of the national policy of decongestion.

E. POLICIES WITH REGARD TO DECENTRALIZATION OF INDUSTRY AND URBAN AREAS

Industrial development on a regional basis acquired considerable significance in actual practice as a result of decisions of XVIII All-Union Congress of the Communist Party of March 16-21, 1939.[36] The Congress set down the following principles to be taken into account in the fulfillment of the third Five-Year Plan for the redistribution of industry, agriculture, and population[37]:

[34] IBID., p. 15.

[35] It was estimated that the population of Moscow reached 5,100,000 inhabitants in 1950, (Schwartz, OP. CIT., p. 386.)

[36] I. I. Evtikhiev, TEKHNIKO-EKONOMICHESKIE RASCHETY PRI PLANIROVKE GORODOV (Technical-Economic Estimates in the Planning of Cities), (Moscow-Leningrad: Gos. Izdatel'stvo Stroitel'noi Literatury, 1941), p. 3.

[37] Davidovich, OP. CIT., pp. 24-25.

1. Develop industries closer to the sources of raw materials and energy so as to avoid waste in transportation.

2. Distribute industry more or less evenly over the entire country so as to create nuclei of industrial and urban culture in the hitherto undeveloped regions.

3. Accelerate the industrialization of the national republics and regions so as to enable them to become equal in fact, not only in law, with the Russian Republic (RSFSR).

4. Encourage production in accordance with the natural and cultural resources of each particular region.

5. Provide for diversification of production within each region so that every region may achieve a certain self-sufficiency within its own territory, and create a number of widely distributed centers for each type of industry in order to ensure continuing sources of supply even though one or two such centers might be thrown out of commission or destroyed.

This national policy pointed to the never forgotten considerations of national defense; to a shifting of the weight to the formerly backward regions of the east; and to a policy of enabling every region to carry on its economic activities without outside help, both in peacetime and during a national emergency.

These guides have had an impact on the character of urbanization and on the practice of city development. Medium and small-sized enterprises began to be distributed over various economic regions of the country. This resulted in the growth of a number of new medium- and small-sized cities and the further penetration of urban settlements into outlying territories, especially the Urals and Siberia. The organized resettling of the Far East had begun this period.[38]

Along with the concentration of population of industrial centers in the East, the growth of cities continued notwithstanding the war. Between 1942 and the end of 1944, 67 cities were built; they fall in three categories:[39]

1. Former small settlements where mining was pressed or enterprises were built to process mineral products—Vorkhuta in the Pechora coal basin, Tkvarcherli in Georgia, and Langer in Kazakhstan.

[38] Parkins, OP. CIT., p. 179.

[39] USSR INFORMATION BULLETIN, Vol. IX, No. 4, (Washington, D. C., February 25, 1949), p. 140.

2. Former workers' settlements in the Urals which were transformed into towns during the war in connection with industrial activities in the Urals—Kizel, Kungar.

3. New cities formed near railroad stations, where trains carrying evacuated plants were unloaded. These rose chiefly between the Volga and the Urals and between the Urals and the Kuzbas. One new town, Astara, in the Transcaucasus, rose as a result of the war-time trans-shipment of foreign freight through Iran.

While trying to prevent a limitless growth of any city, the Soviets do not favor a complete dispersion of the urban population. They believe that the antagonism of city and country can best be overcome by developing industrial nuclei of sufficient strength to serve as centers of urban culture for the surrounding agricultural region; either by building factories in old provincial towns which had previously been merely centers of trade or administration, or by the creation of new cities. It was found that under existing conditions cities under 50,000 usually could not develop satisfactory communal facilities and public services as well as a favorable cultural atmosphere. Without rejecting smaller towns, or the two largest cities of the Soviet Union (Moscow and Leningrad), Soviet authorities are inclined to regard cities of between 50,000 and 500,000 inhabitants as most desirable.

In summary, the Party and the Government in their policy of decentralization and decongestion have repeatedly indicated the importance of limiting the size of large cities. They pointed out that this policy can be carried out in practice only by distributing equally the productive forces throughout the country; and by the development of new industrial centers in regions having favorable natural conditions and available energy. There is good indication that the Soviet authorities intend to maintain this policy.[40]

[40] Sharov, writing in PLANOVOE KHOZIAISTVO in 1949, severely criticized certain local organizations for their practice to extend the size of their existing cities far beyond the 500,000 limit. (A. Sharov, "Voprosy Gorodskogo Stroitel'stva i Khoziaistva" (Problems of City building and Municipal Economy), PLANOVOE KHOZIAISTVO SSSR No. 3, (Moscow: Gosplanigdat, 1950), p. 361.

F. METHODS OF ESTIMATING URBAN POPULATION IN CITIES, IN WORKERS' SETTLEMENTS AND IN SUBURBAN AREAS (OF LARGE CITIES ONLY)

1. INTRODUCTION

The Five-Year Plans, initiated in 1928, brought a radical change in the approach of city planning in the Soviet Union. For the first time in the history of Russia forecasting of what people *might be expected to do* was replaced by a coordinated national plan of what *they intended to do.* The coordinated national plan, often referred to as the social-economic program (or *planirovaniia*) outlines an integrated all-inclusive program of industry, agriculture and socio-cultural activities for a long-range period, usually 15 to 20 years in advance, in fairly detailed quantitative terms for every republic, region and city. Using this definite social-economic program as a framework, the city planner designs the physical plan (*planirovka*) for the long period and for the first stage of construction, usually three to five years.

2. METHOD OF ESTIMATING POPULATION OF A CITY

In the preparation of the general plan for the development of a new city or the reconstruction of an existing one, preliminary estimates are made of the future population for the long-range plan and for the final stage of construction. On the basis of these estimates, the following are determined:[41]

(1) The size of the land areas necessary for residence, industry, municipal facilities, and public services;

(2) The content and sizes of city-wide administrative and socio-cultural institutions;

(3) The structure and scope of engineering improvements (municipal facilities, landscaping, etc.).

The method of estimating the future population of cities and workers' settlements has been well established in the Soviet city planning

[41] Levchenko, PLANIROVKA GORODOV, OP. CIT., p. 24.

practice since 1930.[42] It is derived from the relationship of the following population groups: (1) the basic industries labor force, (2) the servicing group, and (3) the unemployable group.

In the first group belong persons occupied with the basic industry and offices not of local significance but of national, republic, or regional interests: industry, transportation, construction, administrative and culture activities and offices, and higher educational institutions and technicums.[43] In the second group belong those who are employed in offices and enterprises of local significance and who are connected with the serving of the population of a given city: socio-cultural and educational institutions, public feeding, nurseries, health centers and hospitals, commercial stores and shops, housing and municipal economy. In the third group are preschool and school children and all those not able to work.[44]

The size of the first basic industrial labor force group does not depend on the size of the city but on the size of the basic labor force of the country which pre-establishes it. But the number of the second, the servicing group, is directly related or dependent on the size of the total population of the city. The total number of the unemployable group is established by means of analyzing the age structure of the population estimated for the long-range period. In actual numbers it ranges from approximately 45 to 48 per cent of the total population.[45]

The determination of the size of the second, or servicing group, is dependent on the size, nature, importance and potentialities of the planned city. In large cities, with a highly developed municipal economy and a complicated network of socio-cultural facilities, the percentage of employables in servicing these facilities will be higher than in cities with a comparatively smaller population. According to one Soviet authority, the total servicing group is estimated within 20 to 25 per cent of the total popu-

[42] Davidovich, OP. CIT., p. 39.

[43] According to the Soviets' definition of basic industry of a given city, a sausage factory producing sausages for local (city) consumption would not be included in the basic industry and its employees would not be considered part of the basic industry's labor force; they would be part of the servicing group. However, if the same factory produces sausages for local consumption as well as for export, it would then be classified as basic industry, and its workers would be included in the first group. (I. I. Evtikhiev, OP. CIT.,) p. 18.

[44] Levchenko, TEKHNIKO-EKONOMICHESKIE OKNOVY PLANIIROVKI GORODOV, OP. CIT., p. 16

[45] Levchenko, PLANIROVKO GORODOV, OP. CIT., p. 25.

lation.[46] The relative siz of the first group then can be calculated from the remainder of the total after the sum of the other two groups have been determined.

The following table shows the range of indices used by Soviet city planners in estimating the population of the three groups for cities of different sizes.

Table 9. Range of Indices for Estimating City Population*

Cities	Population Groups (in percentages)			
	Basic Industries Labor Force (a)	Servic-ing	Unemploy-able	Total
Large (100,000-500,000 pop.)	28-30	23-25	46-48	100
Medium (50,000-100,000 pop.)	31-33	20-22	45-48	100
Small (20,000-50,000 pop.)	34-35	18-20	45-48	100

*Levchenko, Planirovka Gorodov, op. cit., p. 25.
(a) Levchenko writing two years later proposed that the size of the basic industrial labor force should not be less than 32 per cent for large cities, 34 per cent for medium cities and 30 per cent for small cities. (Levchenko, "Opyt Procktirovaniia Gorodov" (Experience in Planning Cities), (Problemy Sovatskogo Gradostroitel'stva, No. 2, (Moscow: Izdatel'stvo Akademii Arkhitektury SSSR, 1940, p. 40.)

As already noted, the above estimates are for the long-range plan. For the first stage of construction (three to five years), the relationship between the groups will be somewhat different depending on a number of conditions. First of all, the size of the basic industries labor force will be increased at the expense of the servicing group. This is justified on the basis of an incomplete development of the various municipal facilities and public services during the first stage of construction. As these facilities are gradually reaching their optimum utilization at the end of the prospective period, the size of the first group will also decrease with the corresponding increase of the other groups.[47]

Davidovich offers the following guides (Table 10) for estimating the population of the three groups for various-sized cities for the first stage of construction and for the long-range plan:

[46] Ibid.

[47] Ibid., p. 26.

Table 10. Recommended sizes of population groups for various cities for the first stage of construction and for the long-range period*

Population Groups	Relative Sizes of Groups (in percentages)	
	First Stage (3-5 years)	Long Range (15-20 years)
Basic Industrial Labor Force	32-38	28-35
Servicing	11-14	17-21
Unemployable	51-54	48-51
	100	100

*Davidovich, OP. CIT., p. 42.

It will be noted that the figures for the long-range period have greater range than those suggested by Levchenko; however, they merely point up the sizes to expect in estimating the population of the various groups and do not represent actual standards.[48]

After establishing the relative sizes of the groups indicated above, the total population of the city estimated for a long-range period may be expressed by the following formula.[49]

$$N = \frac{A \cdot 100}{100-(B+C)}$$

(N—total estimated population of the city; A—size of the basic industries labor force, expressed in absolute figures; B and C—total number of persons in servicing and unemployable groups.)

3. EXAMPLES OF POPULATION ESTIMATES

a. Stalingrad.

The Soviet city planners who prepared the general plan for the reconstruction of Stalingrad in 1944 estimated its population for the long-range period (15 to 20 years) to be at approximately 500,000 persons.[50] The basic industries labor force was established at 150,000 persons, and consisted of the following components:[51]

[48] Davidovich, OP. CIT., p. 42.

[49] Levchenko, Planirovko Gorodov, p. 25, 650,000 persons if the suburbs are included.

[50] IBID., p. 27.

[51] IBID.

(1) Industry		90,000 persons
(2) Construction		20,000 persons
(3) Higher Educational Institutions (H.E.I.)		15,000 persons
Including:		
(a) Students of five H.E.I'S.	10,000	
(b) Students of 10-12 Technicums and specialized Middle Schools for 50 per cent of the available students; (the other 50 per cent attending regular schools)	2,500	
(c) Pedagogical Personnel	2,000	
(d) Group attending scientific-research institutes	500	
(4) Railroad Transport		10,000 persons
(5) Water Transport		10,000 persons
(6) Administrative, Municipal Economy and other institutions not of city designation		5,000 persons
		Total 150,000 persons

The following relationship between the separate population groups forming the city of Stalingrad was accepted:[52]

Basic Industries Labor Force	30 per cent
Servicing Group	22 per cent
Unemployable Group	48 per cent
TOTAL	100 per cent

The total population of Stalingrad estimated for the long-range period then can be seen from the following formula:

$$N = \frac{150{,}000 \cdot 100}{30} = 500{,}000 \text{ persons}$$

b. Novgorod.

The proposed population was estimated at 60,000 persons. This was based on the basic industries labor force (engaged in all branches of the basic economy and culture) of 20,000 persons, or 33 per cent of the total city population. The sizes of the other groups were calculated from the following group relationship accepted for a small city.[53]

[52] Ibid.

[53] Ibid., p. 28.

Servicing Group 19 per cent
Unemployable Group 48 per cent

From this, the estimated population of Novgorod may be expressed thus:

$$N = \frac{20{,}000 \cdot 100}{100-(19+48)} = 60{,}000 \text{ persons}$$

4. WORKERS' SETTLEMENTS

a. Classification of Settlements.

According to Levchenko, for planning purposes, workers' settlements are classified according to the size of population into three categories:[54]

Large—more than 15,000 persons
Medium—from 5,000 to 10,000 persons
Small—up to 2,000 persons

This classification is accepted by many of the city planning profession but is not iron-clad.

b. Method of Estimating Population of Workers' Settlements.

The following table shows the estimated population of the three groups for three different types of workers' settlements:

Table 11. Estimated Sizes of Population Groups for Workers' Settlements*

Workers' Settlements	Population Groups(in percentages)			
	Basic Industries Labor Force	Servic-ing	Unem-ployable	Total
Large	33	17	50	100
Medium	35	15	50	100
Small	38	12	50	100

*Levchenko, TEKHNILO-EKONOMICHESKIE OSNOVY PLANIROVKI POSELKOV (Technical-Economic Bases for Planning Settlements), OP. CIT., p. 17.

5. SUBURBAN AREA

The suburban area of large Soviet cities closely resembles the metropolitan area in American practice, and generally embraces similar planning problems. Simultaneously with the planning of a city is pre-

[54] Levchenko, TEKHNIKO-EKONOMICHESKIE OSNOVY PLANIROVKI, OP. CIT., p. 10.

pared a general plan of the agricultural-economic development of the entire surrounding suburban territory. This suburban area plan determines the location of the various functions of municipal economy, industry and transport which are to be located in a suburban zone, according to their character and nature of operation. These include: (a) suburban places of residence, suburban places of rest—forest parks, summer camps, rest homes and tourist camps; (b) sanitation installations and other municipal utility projects such as water sheds, sewage disposal fields; (c) intra and outer transports; (d) industrial areas; (e) agricultural lands for the production of fruit, vegetables and milk; (f) enterprises for the extraction and production of local building materials; (g) airfields; (h) land reserved for future expansion of the city; and (i) defense needs.[55]

a. Method of Estimating Population of Suburban Area.

The method of estimating future population of suburban areas is the same as that used for cities. The example cited below, prepared in 1939 for the suburban area of Moscow, is not typical but sufficiently detailed to illustrate the method used by Soviet city planners.

Table 12. Population Estimate of the Moscow Suburban (Metropolitan) Area, 1939*

Population Groups		Percentage of Total
1. Basic Industries Labor Force		39.0
Industry	12.9	
Transport	.5	
Construction	1.8	
Agricultural Economy	11.8	
Specialized Educational Institutions	6	
Suburban (Metropolitan) Administrative and Communal Institutions	.5	
Health and Rest Facilities	.4	
Suburbanites (working in Moscow)	5.0	
Others	5.5	
2. Servicing		6.7
3. Unemployable		53.5
4. Seasonal Population (those taking rest cures during the winter)		0.8
	TOTAL	100.0

*M. O. Khauke and K. O. Bulgakov, PLANIROVKA PRIGORODNOI ZONY (Planning of the Suburban Zone), (Moscow: Gos. Izd-vo. Arkhitektury i Gradostroitel'stva, 1951), p. 25.

[55] Evtikhiev, OP. CIT., pp. 69-71.

Estimates of population of suburban areas for other cities are generally based on the following recommended indices:[56]

Basic industrial labor force	35-36 per cent
Servicing group	12-15 per cent
Unemployable group	50-52 per cent
	100 per cent

b. Distribution of Suburban Area Population.

The distribution of population in the suburban area may take various forms, depending on local conditions. The general existing distribution has followed a lineal pattern along the major transportation lines leading to the city. Among the various existing forms of population "sprawl" in the suburban area may be distinguished three basic types:[57] radial, lineal or "ribbon", and cluster.

The radial type of distribution forms a wide belt (sometimes two kilometers or about 1.25 miles) along the railroad lines converging on the city. The ribbon type is found in the form of narrow strips or regular rows of residential buildings, along both sides of the major highways entering the city. Finally, the cluster type is found around industrial concentrations and large suburban institutions distributed within the suburban area, surrounded by woodlands and open agricultural lands. All these types are found in the Moscow suburban area.

Of these three forms of suburban population distribution, the cluster type, or commonly referred to as the satellite town, is preferred by the Soviet city planners. The main requirement for locating the satellite town is that it must be close to centers of labor supply as well as to good transportation lines leading to the city. For suburbanites, that is, those persons employed in the city but living in the suburbs, the maximum distance from place of residence to place of work has been established as being that distance covered by one hour's travel time. For the rest of the population living in workers' settlements and towns of the suburban area, having their own local economic base, the time of travel to the city should not take more than two hours—"portal to portal."[58]

[56] Khauke and Bulgakov, OP. CIT., p. 26.

[57] IBID.

[58] IBID.

G. COMPOSITION OF LAND USE PLAN OF SOVIET CITIES

1. CHARACTERISTIC FEATURES OF RUSSIA'S SOVIET CITIES

Russian cities up to the 18th century generally had two or three encircling walls with a centrally enclosed stone kremlin. Russian cities were wooden cities and consequently were of low-story construction spatially distributed along wide streets.

The typical Soviet city in European Russia is built on flat ground, and perhaps for that reason the street pattern is usually rectangular. In the central part of the city, brick or stone is the building material most commonly used, but in the outskirt, timber predominates. The streets are laid out to a generous width, with the original object, no doubt, of preventing the spread of fires. Congestion of traffic, as we know it, does not exist in most Russian cities. Even in Moscow the number of vehicles in circulation is small in comparison with Chicago. Few passenger automobiles are at present available, but street cars and trolley buses are used so extensively that they are chronically overcrowded. In Moscow relief was provided by the construction of a subway; Leningrad is now building its subway system.

The tallest buildings[59] are concentrated in the center of the city, with lower structures farther from the center, finally reaching the single-family residential development zone on the periphery.

a. City Center and Squares.

The city center, equivalent to the civic center or the New England "commons" of the United States, has been an intrinsic architectural feature of Russian cities since the beginning of the 18th century.[60]

As an administrative, political and social core of the city, the city center has assumed even greater importance now than before World War II. In old Russian cities the center was dominated by the kremlin

[59] In medium-sized cities the tallest buildings average three to four stories; in large cities, five and six. In Moscow, many multi-story structures of 14, 17, 26 and 32-stories are now being built.

[60] Bunin et al, OP. CIT., p. 212.

(Moscow and Novgorod). The characteristic center of new or reconstructed Soviet cities has a square designed to provide a large open space for parading troops and for people on holidays and important occasions. The center serves as a setting for principal public buildings and monuments. The architecture of the city center is grandiose, severe and monumental and dominates all other construction of the city. The effectuation of city centers is usually given first preference.[61]

The Soviet city planners consider only four types of squares for their cities: public—usually in the center of the city for demonstations and parades; transport—junctions for city movement (crossings of thoroughfares, approaches to bridges); loading and unloading (freight and passenger)—at railroad stations, freight distribution centers, docks and wharves and near theaters, stadia, parks and industrial enterprises; and commercial—according to the type of commerce and market (lumber, grain, cattle). In small towns or settlements one main square can serve all purposes.[62]

b. Industry.

It cannot be too strongly emphasized that this is the dominating factor in the planning of Soviet cities. The location of some industrial enterprises depends entirely on the presence of mineral deposits or other raw materials; the situation of others is governed by transport facilities, while others, again, are designed to accommodate a group of industries drawing their supply of power from a common source.

The national economic plan not only indicates the general position of the major industries but also their character and approximate size. With such knowledge in his possession, the Soviet city planner is able to estimate the size of the industrial area and the scale at which the necessary services should be provided. The nature and extent of subsidiary enterprises can also be deduced, and these are carefully distributed so as to avoid unnecessary waste.

An industrial area is designed to accommodate not only the plant but also training facilities including technical institutions, trade schools, and scientific research laboratories; it is considered that the education of students in technical skills is facilitated by the close proximity of the industry whose methods of production they are studying.

The distribution of industries in Soviet cities may be either scattered over separate areas of the city or concentrated in one of several

[61] M. F. Parkins, City Planning in Soviet Russia; An Interpretative Bibliography (Cambridge, Mass.: Russian Research Center, Harvard University, 1949), p. 85.

[62] Poliakov, op. cit., pp. 222-223.

areas in the form of industrial districts. A scattered distribution with narrow protective green belts may be acceptable only for those industries that are not noxious to residential areas, or have little relation with other industries and that require little freight turnover and limited demands on the area in which they are located.[63]

Standards have been established for "sanitary protective zones" or green belts between industries and residences. The width of these protective belts, depending on the type of industry and the degree of its harmfulness on the residential districts, range from 2,000 meters (about 6,000 feet) for chemical plants to 100 meters (about 300 feet) for small textile mills.[64]

c. Residential.

The residential areas of the city are directly dependent upon the industrial zones as regards both extent and position. Their extent can be estimated with some degree of accuracy from the type of the industry which forms the basis of the Soviet city, and consequently the relative sizes of the population groups discussed above; their position is determined by the desire to protect the inhabitants from the effects of smoke and fumes by building their dwellings on the windward side of the industrial area.

2. THE RESIDENTIAL SUPERBLOCK.

The Soviet city planners were pioneers in developing the modern principle of neighborhood unit planning and have achieved considerable success in the planning of groups of dwellings and their necessary services.

The superblock, forming part of the housing plan of a newly built or reconstructed residential district, is designed as an organized land unit, spatially predetermined in its relationship to the surrounding superblocks and to the compositional structure of the city as a whole. The following are the characteristics and the features of the superblocks of this type as the Soviet city planners conceived them.

a. Population and Density.

In a superblock, dwellings would be distributed over a land surface whose area and population density, established in advance, would be limited to the degree most appropriate for the residential district. With the distribution of the population being planned in advance, the superblock would therefore be composed of the dwellings required to house a suffi-

[63] Levchenko, PLANIROVKA GORODOV, OP. CIT., p. 34.

[64] Poliakov, OP. CIT., pp. 84-87.

cient number of people to support the necessary neighborhood facilities and services. According to the plans for the development of the residential districts of Moscow and Leningrad, the population in the individual superblocks ranged from 3,600 to 7,500 persons for Moscow[65] and from 3,000 to 6,500 persons for Leningrad.[66]

b. Size.

The residential density selected for a superblock will influence its size, as will also the predetermined percentage of convenient building coverage, type and height of residential structures, age groups to be accommodated, and the other planning standards adopted for local conditions. The sizes of the superblocks proposed for Moscow and Leningrad range from 9 to 15 hectares (about 23 to 38 acres)[67] and from 5 to 13 hectares (about 8 to 33 acres),[68] respectively, with the convenient sizes of the superblocks calculated for six to eight minutes of walking distance to transportation facilities. The height of the buildings was to be five to six stories; its building coverage, about 20 per cent; and average density, 400 to 500 persons per hectare (about 160 to 200 per acre).[69]

In other cities the areas of a superblock vary from three to six-eight hectares (about 8 to 16-20 acres), depending on the existing topography, wind direction, and to a considerable extent, the street pattern. The height of apartment buildings would be correspondingly lower—three to four stories in the central districts and one- and two-story buildings in the outskirts.[70]

c. Neighborhood Facilities and Services.

Depending on the size, density and composition of the people, and the relationship to other primary cells, the superblock may include any or all of the following facilities and services: nurseries, kindergartens, schools, a post office branch, garages, and indoor and open-air recreation space for both children and adults. Most of these services are usually lo-

[65] P. I. Gol'denberg, "Kvartal v Novoi Moskve" (The Residential Superblock in the New Moscow), ARKHITEKTURA SSSR, No. 10-11, (Moscow: Gos. Arkh, Izdpvo., Nov.-Dec., 1935), pp.59-61.

[66] B. Rubanenko, "Kvartaly Avtovo v Leningrada" (Superblocks of Avtovo District in Leningrad), ARKHITEKTURA SSSR, Vol. 9, No. 5 (May, 1941), p. 35.

[67] Gol'denberg, OP. CIT.

[68] Rubanenko, OP. CIT.

[69] IBID.

[70] Gol'denberg, OP. CIT.

cated near the central area of the unit, either on the first-floor of the residential apartments or in separate buildings surrounded by park spaces. Those which follow are generally distributed throughout the areas adjoining the main highways which isolate the dwellings from traffic nuisances: movie house, local stores (drugstore, grocery, etc.), garages, and small dispensary for emergency cases.[71] Through-traffic streets are not permitted to separate dwelling units by entering the superblock area, but they by-pass them by means of parkways.

3. THE RESIDENTIAL SUB-DISTRICT AND DISTRICT.

A group of superblocks forms a microraion or residential sub-district. Two or more such sub-districts make up a *raion* or residential district.[72] Certain community facilities and services whose efficient operation requires greater populations were planned to serve these larger areas. These include secondary schools, an auditorium for lectures and concerts, "socio-cultural" clubs, library, department store, theater and movie house, dispensary and clinics, hospital, public baths, stadium and playfield, district park, telephone and other administrative offices and communal facilities.[73] Most of these community facilities would be concentrated in special service areas located centrally to the sub-districts. The administrative offices and other communal buildings are grouped around a central square, which is the dominant feature of each district, just as the city center is the dominant element of the city. Certain new residential districts in Moscow range up to 200,000 inhabitants.

4. BUILDING ZONES.

As a general rule, the distribution of the residential areas according to type and height of structures, population density, and building coverage is accomplished by means of building zones. Six building zones have been established, depending on the size and character of the city, and availability of building area and local building resources (Table 12A). Building zones may apply only for residential structures or for mixed con-

[71] Parkins, THE DEVELOPMENT OF CITY PLANNING IN SOVIET RUSSIA, OP. CIT., p. 56.

[72] In Moscow, the new residential districts range from 50 to 100 hectares (about 125 to 250 acres).

[73] With a density of 400 inhabitants per hectare (about 160 per acre), a residential district with an area of 75 hectares (about 188 acres) would accommodate about 30,000 inhabitants. To service this population the following education facilities are recommended: Approximately 6 schools, 12 kindergartens and 9 nurseries. (A.A. Galaktionov, "Zastroika Zhilykh Raionov" (The Development of Residential Districts), PROBLEMY SOVETSKOGO GRADOSTROITEL'stva, No. 2, (Moscow: Izdatel'stvo Akademii Arkhitektury SSSR, 1949) p. 36.)

struction (residential, administrative, commercial and non-noxious industrial buildings.)[74]

Table 12A. Classification of Building Zones of Residential Buildings According to Height of Structures, Population Density and Building Coverage*

Building Zone	No. of Stories	Residential Density: Persons per Net Hectare of Residential Land with a Sanitary Norm of 9 m.² of Living Space per Person (a)	Percent of Building Area
I	4-5	450 (abt. 180 pers./acre)	25-30
II	3-4	350 (abt. 140 pers./acre)	25-30
III	2-3	250 (abt. 100 pers./acre)	25-30
IV	2	200 (abt. 80 pers./acre)	20-25
V	2-1	180 (abt. 70 pers./acre)	20-25
VI	Single-family houses on individual plots	60-100 (abt. 24-40 pers./acre)	—

*Levchenko, Planirovka Gorodov, OP. CIT., p. 43.

(a)The "sanitary norm" of 9 m.² per inhabitant was established in the early years of the Soviet regime. This "norm" determines the right to "living space," which is basic in Soviet Housing Law. The "sanitary norm" of 9 m.² has never been changed, though the average in practice is of course much lower. (Parkins, OP. CIT., p. 14). "Living space", as defined in Soviet statistics is always figured in square meters per person and includes the area of living and sleeping norms. The floor space occupied by dining-kitchen, bathroom, halls, staircase, pantries, etc., is not counted. (IBID, p. 56) Net Residential Density, as used in this report, denotes: average number of persons per hectare (about 2.5 acres) of housing area with its residential streets and other facilities directly serving the residents, but excluded major roads, large packs and city-wide facilities and services.

In large cities all of the six classes of building zones may be used; in medium-sized cities, not more than five, beginning with Class II; and in small cities, only the last three or four classes may be used, as is shown in Table 13. However, even in large cities the number of classes may be reduced, depending on the use of combinations of buildings of different stories. Thus one zone may consist of three- to five-story buildings, while the two-story zone may be entirely eliminated.[75]

[74] Levchenko, OP. CIT., p. 39.

[75] Levchenko, OP. CIT., p. 43.

Table 13. Recommended Scheme for Zoning of Residential Buildings in Cities of Different Sizes*

Building Zones by Classes	No. of Stories	Cities: Large (100-600,000 Pop.)	Cities: Med. (50-100,000 Pop.)	Cities: Small (20-50,000 Pop.)
		Percentage of Residential Area or Population.		
I	4-5	40-50	—	—
II	3-4	40-50	20-25	—
III	2-3	25-35	35-45	25-35
IV	1-2	10-15	15-20	30-50
V	Single-family houses on individual lots	15-20	20-25	25-35

*Levchenko, PLANIROVKA GORODOV, OP. CIT., p. 53.

5. DISTRIBUTION OF BUILDING ZONES.

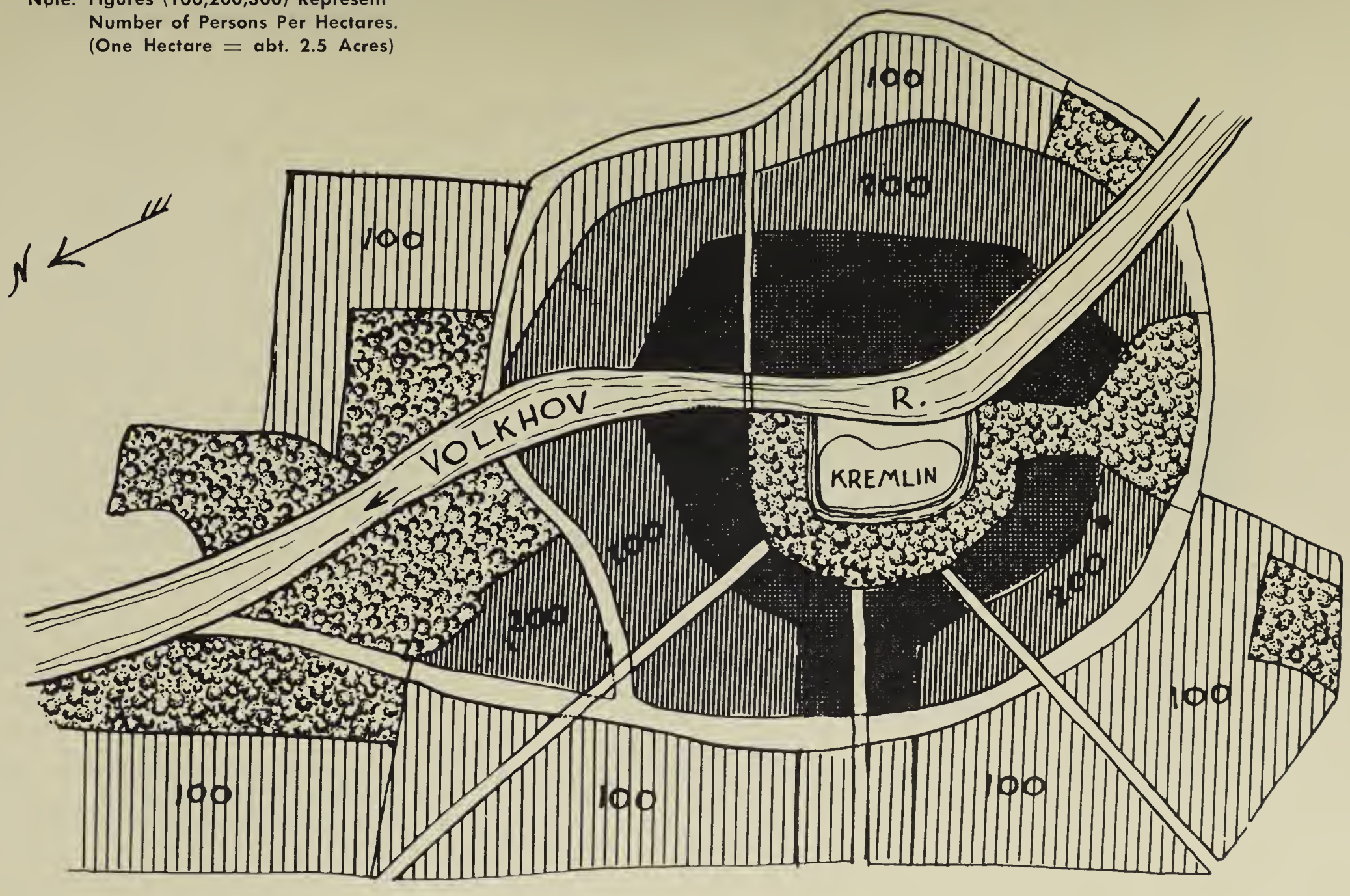
The recommended practice for distributing building zones in Soviet cities is to concentrate the tallest structures in the center of city, with lower structures farther from the center, finally reaching the single-family houses built by individuals on separate lots.[76] As an illustration of this scheme, Figure 1 is presented showing the concentric distribution of the building zones of the city of Novgorod (population in 1939: over 40,000 persons).

In large cities, where in addition to the city center are usually found residential district centers as well as isolated spots containing tall structures, the building zones do not always follow the concentric pattern. However, Levchenko maintains that in general this scheme of distributing building zones is fairly well maintained throughout the country.[77]

Figure 2, showing the distribution of building zones for the city of Stalingrad, illustrates another form of building zones. Since Stalingrad is laid out in a long narrow ribbon along the Volga River, the distribution of the building zones was influenced by existing local conditions of its separate parts. Almost half of Stalingrad's population is concentrated in the citys peripheral districts serving large industrial enterprises.[78]

[76] Levchenko, "Zonirovanie Gorodov po Kharacteru Zastroiki" (Zoning Cities According to the Character of Structures). PROBLEMY SOVREMENNOGO GRADOSTROITEL'stva No. 1, (Moscow: Izd-vo. Akademy Arkhitektury SSSR, 1947), p. 19.
[77] IBID., p. 20.

Note: Figures (100,200,300) Represent
Number of Persons Per Hectares.
(One Hectare = abt. 2.5 Acres)



ADAPTED FROM IA.P. LEVCHENKO, PLANIROVKA GORODOV, TE KHNIKO-EKONOMICHESKIE POKAZATELI IRASCHETY (MOSCOW: IAA, 1947), P. 44.

FIG.1. NOVGOROD. SCHEME OF BUILDING ZONES

Note: Figures (100,200,230.400) Represent
Number of Persons Per Hectare.
(One Hectare = abt. 2.5 Acres)

⊠ INDUSTRY

ADAPTED FROM IA.P. LEVCHENKO, PLANIROVKA GORODOV . . . OP. CIT., P. 46

FIG. 2. STALINGRAD. SCHEME OF BUILDING ZONES

6. RECENT TRENDS IN RESIDENTIAL BUILDING

Since 1939-1940 the general policy has been to discourage the building of tall structures in Soviet cities. According to Levchenko, the plans for the reconstruction of Soviet cities before World War II show not more than 50 per cent of the total proposed housing in multi-story structures (three stories and up). In city-planning practice after World War II this figure was no more than 30 to 35 per cent.[78]

It is interesting to mention that Russian cities before the Revolution were principally of low-story construction, and in spite of considerable multi-story construction during the three Five-Year Plans, the average height of buildings did not reach more than 1.5 to 1.6 stories before World War II.[79] Plans prepared during the last few years indicate about one-third of the total proposed housing to be of three and more stories for large cities and about a fourth for medium-sized cities; in small cities multi-story construction will be concentrated only in the city center or along the principal roads. The relative height of two-story buildings will average about 30 to 40 per cent of the total housing in large cities and up to 50 per cent in medium- and small-sized cities. Finally, single-story single-family construction (to be constructed mostly by private individuals from private resources) will constitute about one-fourth of the total housing in large cities; about a third in medium-sized cities; and one-half of the total proposed housing construction in small cities.[80]

[78] IBID.

[79] Levchenko, "Opyt Proektirovaniia Gorodov" (Experience in Planning Cities), PROBLEMY SOVETSKOGO GRADOSTROITEL'SVA, No. 2 (Moscow: Izdatel'stvo Akademii Arkhitektury SSSR, 1947) p. 41.

[80] IBID., p. 42.

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